LONGWALL DEMONSTRATION IN WESTERN CANADIAN COALS

PHASE 1 - MINE PLANNING & SYSTEMS ENGINEERING

CONTRACT #0SQ82-00107

VOLUME 1

TECHNICAL REPORT

Prepared by McIntyre Mines Limited

For Canada Center for Mineral
and Energy Technology

214 pp
27 figures

14 January 1983

MICROMEDIA
OCT 20 1983

PREFACE

Considerable resources of high quality coal contained in thick inclined seams are located in Western Canada. Current room and pillar underground mining systems are severely limited in their ability to recover these resources safely and efficiently, reducing the proportion of the resource that can be classified as mineable.

Recent technological advances have enabled longwall installations to successfully operate in seams up to 16 ft thick, inclined at up to 70 degrees. Successful introduction of this technology to Western Canada could substantially improve safety, resource recovery and the competitive position of Canada in export markets. To ensure successful operation, equipment specifications must be based on site specific data.

Smoky River Coal Limited, a wholly owned subsidiary of McIntyre Mines Limited, operates a complex of surface and underground mines in the Smoky River coalfield in West Central Alberta, with capacity to produce some 2.0 million tons of high quality metallurgical coal for market. In 1981, 643 500 tons were obtained from underground mining operations. McIntyre has identified an area of mineable coal at the Smoky River No. 9G Mine suitable for demonstration of longwall mining techniques.

Following general acceptance of a background paper prepared by McIntyre concerning this possibility and circulated to CANMET, Alberta Government agencies, the Coal Association of Canada and the Coal Mining Research Centre, McIntyre submitted a proposal to CANMET to conduct a detailed feasibility study of a demonstration longwall at McIntyre's Smoky River No. 9G Mine. Detailed terms of reference are included in Appendix 2-1.

Concurrent with submission of McIntyre's proposal, CANMET commissioned Montreal Engineering Company to assess the potential for a longwall demonstration in Western Canada. The Montreal Engineering study concluded that the site proposed by McIntyre was appropriate for a meaningful longwall trial to be conducted. Approval to proceed with Phase 1 Mine Planning and Systems Engineering was given by CANMET on September 16 1982.

This report outlines the development of the Smoky River operation, provides data on regional geology and coal reserves, describes current operations and presents a detailed engineering study concerning recovery of coal reserves contained in Seam #4 at McIntyre's Smoky River No. 9G Mine by longwall. If suitable risk sharing agreements can be reached with other interested agencies, and market conditions are favourable, McIntyre would consider developing the 9G-4 Mine for extraction by longwall.

McINTYRE MINES

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01 February 1983

Mr. George Zahary
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Coal Research Laboratories
Bowpoint Plaza, Room 380
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Dear Sir:

Re: Contract No. 0SQ82 - 00107

In compliance with the requirements of the above contract, seven copies of a report contained in four volumes entitled "Longwall Demonstration in Western Canadian Coals - Phase I Mine Planning and Systems Engineering', accompany this letter. Additional supporting data in the form of manufacturers equipment tenders have already been supplied.

Enclosed also are:

1. Three copies of an addendum detailing financial information, which McIntyre request remain confidential for at least two years, and
2. A key to the codes used to maintain commercial confidentiality in the Tender and Economic Assessment sections of the report.

The submission of the reports and supporting data completes our response to the requirements of the contract.

Yours very truly,

McINTYRE MINES LIMITED

Bacharach

J.P.L. Bacharach
Vice President, Operations

JPLB/sds
Encl.

Key to Tender Identification

Technical Assessment

Dowty	Supplier	A
Gullick		B
Hemscheidt		C
Klockner Becort		D
Long Airdox-Mitsui		E

Economic Assessment

Dowty	Option	1
Gullick		1
Hemscheidt		3
Klockner Becort		3
Long Airdox-Mitsui		2

Joy Manufacturing declined the invitation to tender.

REPORT FORMAT

This report is entitled **Longwall Demonstration in Western Canadian Coals Phase 1 Mine Planning and Systems Engineering.** For convenience a short title, **Longwall Demonstration Phase 1,** is used. The report briefly describes the development and current status of the Smoky River operations, provides data on regional geology and coal reserves and presents a detailed engineering study concerning recovery of coal reserves from McIntyre's Smoky River No. 9G-4 Mine by longwall. Phase 2 would encompass the actual procurement and operation of longwall equipment at the No. 9G-4 Mine.

In the report the term **in place coal** is used to describe unmined coal in its geologic location. **Run-of-mine** coal is used to denote mined coal prior to any form of sizing at the coal preparation plant facility. **Raw coal** is used to denote run of mine coal which has been subjected to sizing prior to processing in the preparation plant. The term **clean coal** denotes coal which has been processed to meet market specifications.

The report has been prepared in Imperial Units, consistent with the company's statistics, and throughout the report, where reference is made to tons of coal, long tons of 2240 pounds are implied.

The report consists of four volumes, **Volume 1 Technical Report** supported by three volumes of appendices, thus:

Volume 1	Technical Report
Volume 2	Appendices - McIntyre References
Volume 3	Appendices - Consultants Reports
Volume 4	Appendices - Longwall Equipment

Volume 1 Technical Report consists of nine sections.

Section 1 **Background to the Study** briefly describes the development of mining systems in Europe and North America, with particular attention to the application of these systems to Western Canada in general and to McIntyre's Smoky River operations in particular.

Section 2 **Smoky River Operations** provides a detailed description of the Smoky River operations, including a description of the No. 9G-4 Mine at its current stage of development together with the mines infrastructure and support services.

Section 3 **Design Considerations** addresses the general principles of planning and design for longwall operations. Parameters derived have been used subsequently to develop detailed mine design and operating sequences.

Section 4 **Reserves and Design Parameters** addresses in detail the general design parameters discussed in Section 3 and the factors which affect mine design for application in No. 9G-4 Mine. Appropriate parameters have been derived and used to develop the detailed mine planning and systems engineering. To ensure selection of the most appropriate design several practical layouts are compared and one of these developed further as the recommended design.

Section 5 **Longwall Design for No. 9G-4 Mine** undertakes the detailed design for longwall in No. 9G-4 Mine, based on resource data and parameters developed in Section 4. Alternative mining layouts including single and multiple entry systems are compared, and a recommended layout proposed.

Section 6 Longwall Operations discusses each phase of the longwall operation including development, equipment installation, production and transfer of equipment.

Section 7 Longwall Equipment Tenders discusses preparation of an invitation to tender for the supply of longwall equipment, and assessment of tenders received.

Section 8 Management of a Longwall Demonstration Project discusses management and control of the longwall demonstration project, identifying terms of reference for the Project Steering Committee, recommendations for research and the need for training of supervisory and operating personnel.

Section 9 Economic Evaluation presents an assessment of costs and an economic evaluation of the proposed longwall demonstration project.

Tables and Figures are referenced in the text and appear at the end of each section to which they relate in the order stated. **Appendices** are referenced by number, the first number identifying the report volume in which the appendix appears.

The **Technical Report** in this volume, Volume 1, is preceeded by a summary statement of **Findings, Conclusions and Recommendations** which follow.

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

FINDINGS AND CONCLUSIONS

Technical

In terms of geological and geotechnical parameters, there are no significant barriers to the successful application of longwall in the target area of No. 9G Mine.

Detailed consideration of the reserves has shown that an appropriate layout for longwall mining can be designed, and that the development work can be undertaken with existing equipment and systems. A machine capable of driving development headings in the more steeply inclined areas of the mine has been identified.

Conservative production performance calculations for development and longwall mining show that both activities can be phased to provide continuing longwall operation.

At the required manpower level of about 150 with overtime estimated at 12%, productivity would average 26 tons of raw coal per manshift at the mine-mouth.

The submission of very detailed tenders for the supply of longwall equipment, including favorable performance guarantees and purchasing arrangements, in response to a site specific enquiry document clearly demonstrates manufacturers support for the technical feasibility of longwall in No. 9G Mine.

Existing services and infrastructure at No. 9G Mine can be readily expanded where necessary to accommodate longwall.

While the project has been evaluated as a demonstration and this feasibility study is based upon the extraction of three longwall panels, in practice if demonstrated to be viable, longwall operations would be continued, and the equipment would be transferred to other areas of the mine. Potential areas for continued longwall operations in No. 9G-4 Mine have been identified.

Economic

Longwall equipment can be procured for installation in the No. 9G Mine at a capital cost of $12.5 million. Based on current mining costs for development and estimated cost for longwall the resulting cost to produce and transport coal to a mine mouth stockpile would be:

Year	$
1	33.53
2	13.46
3	12.96
4	13.53
5	11.64

At the current sales price the longwall demonstration would provide a positive cash flow after the first year of operation and an acceptable net present value. Continued operation of the longwall system, beyond the demonstration phase, would improve the overall economic picture.

However, if longwall were implemented it would displace other production capacity and must achieve the projected production levels throughout the project life both to ensure the required rate of return and to meet market commitments.

Development to prepare the No. 9G Mine for longwall will require significant expenditure in the first year of the project. This is in addition to the capital expenditures already incurred by McIntyre to establish the mine to its present stage of development.

Development of No. 9G-4 Mine for longwall would not be readily converted for extraction by room and pillar methods. Thus, if the longwall system failed to operate to projected output levels there would be a significant risk of production and financial loss.

While a successful longwall at No. 9G Mine would provide an attractive return on investment, the viability of longwall cannot be considered in isolation at a mine currently operating both surface and underground facilities, although it may be prudent to do so for a new mine development. Therefore, before installation of longwall at Smoky River can be contemplated, even as a demonstration, two major factors must be considered:

- Market availability for longwall incremental production.
- Availability of risk capital for the demonstration project.

Whilst both technical and economic considerations are positive, the longwall would be unique in Western Canada. At present no relevant Western Canadian operating experience is available. The involvement of CANMET and other agencies may be essential to minimize the risk to the operator and to share the burden imposed by the requirement for large sums of up-front capital, until the longwall systems' viability is proven.

Present circumstances dictate that, unless markets can be found for the incremental production from longwall, and risk capital can be procured, it is unlikely that the demonstration can proceed at the present time.

As a result of the recent contraction in markets for Smoky River coal and the consequent under-utilization of existing production capacity, the current climate is not favorable for the investment of significant sums of risk capital on a longwall trial. However, the reduction in demand for coal as a result of a recession is not uncommon to the mining industry.

As the economic environment improves, coal production will increase to meet demand, alleviating existing economic and investment constraints. The advantages to be gained from longwall viewed against an improved market would provide a more favourable background for a longwall demonstration.

RECOMMENDATIONS

Although the depressed coal market presents a barrier to the a demonstration longwall at this time, the current situation should not be accorded undue influence or allowed to overshadow the positive benefits that will accrue to the mining industry and research organizations from a demonstration longwall in appropriate circumstances. When the current recession eases and demand for coal improves, the following recommendations should be implemented:

1. CANMET should participate in a joint venture longwall demonstration project in Western Canada. A suitable site for such a project is No. 9G-4 Mine at Smoky River Coal Limited. Three longwall panels could be extracted over a total period of some four and a half years. The panels proposed would enable both the development and production phases of longwall mining to be evaluated in different mining conditions, including gradients up to 30°. The specification of a typical panel would be:

- Development system	2-entry
- Face length	550 ft
- Extracted height	10 ft
- Pillar width	120 ft
- Direction of mining	Retreat/faces on-dip
- Panel run	4800 ft

2. CANMET and other interested agencies should be prepared to invest significant capital to initiate a demonstration project. This would reduce the proponents initial capital expenditure and share the risk associated with the application of a new mining technique in Western Canadian conditions. CANMET and other interested agencies who may make a capital contribution to the project should develop a means by which the expenditure incurred could be recouped if the demonstration proves successful. For example, repayment could be effected by the imposition of a surcharge on each raw ton produced above an agreed break-even production figure.

3. As early as possible following a decision to proceed with the demonstration project, CANMET should form a Steering Committee and Project Management Group. CANMET's representative on each of these groups should be a qualified mining engineer with longwall mining experience. The Steering Committee should confirm the objectives for the program, monitor the performance of the demonstration and ensure that appropriate information is collected and properly disseminated. The Project Management Group should be responsible for the mining operations and research activities, receiving guidance from and reporting to, the Steering Committee.

4. The consideration of other sites is outside the scope of this report. Undoubtedly, benefits could be obtained from a longwall demonstration at other locations, but before alternate sites are considered as candidates, CANMET should require and fund appropriate site specific studies to complement the work presented in this report.

5. A demonstration longwall will produce large volumes of coal and is likely to affect the production plans of any mining company involved. CANMET should assure themselves of the market for coal produced from the longwall for the demonstration period before undertaking any significant capital expenditure on equipment.

6. It is unlikely that a more suitable site than that reviewed in this report will become available in the near term. CANMET should explore with Smoky River Coal Limited and other agencies every possible avenue by which a demonstration may be initiated at this location.

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LONGWALL DEMONSTRATION
PHASE 1

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1.0 BACKGROUND TO THE STUDY

1.1 INTRODUCTION

Section 1 briefly describes the development of mining systems in Europe and North America, with particular attention to the application of these systems to Western Canada in general and to McIntyre's Smoky River operations in particular.

1.2 HISTORICAL

Until the advent of mechanization in the early 1900's, mining methods were manpower intensive and hazardous. Mining operations were generally conducted with little concern for human dignity or safety.

The exhaustion of easily mined shallow reserves forced the exploitation of deeper and more difficult seams and new technology and mining systems were developed to allow more efficient and safer production in these conditions. A major step was made during the 1940's when the flexible armoured conveyor was introduced. This development and subsequent powered roof support innovations in the 50's to 70's was the forerunner of mechanical longwall mining which is now employed to extract the major portion of all coal mined underground in Europe. Using longwall, European mines have established enviable safety records, attaining high levels of productivity where mining conditions permit.

In countries where underground coal mining developed later, such as Canada and the US, machinery and mining systems were determined by the configuration of reserves available for mining. In North America large areas of relatively shallow, level reserves too deep for open pit mining were available for exploitation. Consequently, mechanized room and pillar systems were developed to replace hand mining methods. Such systems are both highly productive and safe under suitable conditions. Room and pillar systems in Western Canada are frequently operating at or beyond the optimum limits for their application.

Currently, reserves efficiently exploitable by room and pillar are becoming depleted and longwall systems are being introduced to new mines. Both room and pillar and longwall systems are being evaluated in relation to productivity and safety in existing mines and in many instances longwall is being employed because of its intrinsic advantages over room and pillar.

1.3 COAL DEVELOPMENT

In Western Canada, coal reserves occur in two major geographic areas; the Plains and the Foothills/Mountains Regions.

Plains coal seams are generally level and of consistent thickness over large areas. Coal is of sub-bituminous rank and as such is unlikely to command a price sufficient to allow exploitation for export.

Foothills/Mountain coals are contained in seams which can vary considerably in inclination and thickness. Coal may be low, medium, or high rank and can be exploited for export as metallurgical and thermal coals.

The earliest recorded mining activity in Alberta dates from 1897. Today, frequent reporting of previously unrecorded shafts or surface subsidence indicates that mining did take place prior to 1897.

The coal mining industry in Alberta developed initially in response to a demand for home heating fuel. Following establishment of the railways, the coal industry expanded rapidly and reached a peak in 1945 when approximately 9 million tons were produced.

The discovery of large reserves of oil and gas in Alberta, coupled with the railway dieselation program significantly reduced demand for coal. This situation persisted for some years and as a result, continuity of expertise available in the industry was lost and underground mining technology development in Western Canada was significantly retarded.

Following Alberta Government policy directives requiring coal-fired electrical power generation, and establishment of an offshore export market for metallurgical coal, the coal industry entered a steady growth phase with current projections indicating continuing growth in coal production.

1.4 LONGWALL EXPERIENCE

When the Smoky River mine was initially developed it was planned that all production would be obtained from two underground mines located one on either side of the Smoky River adjacent to the main plant site. Annual planned output was to be 2 million tons clean and the mining method proposed was longwall with development work being undertaken by continuous miners. Two longwall faces were planned.

In October 1970 the first longwall went into operation in No. 5 Mine 503 District. In January 1971 the second longwall face commenced operation in No. 2 Mine 205 district. Due to circumstances discussed later, both longwall faces were stopped in July 1971. To meet contractual commitments surface mining operations were developed at No. 8 Mine and room and pillar extended underground.

It is difficult to accurately determine why longwall failed at this time since little documentation exists. However, it is certain that the following problems contributed:

- Inappropriate roof support design with inherent deficiencies.
- Poor roof control on the face.
- Floor penetration.
- Delays in equipping the face.
- Effects of adjacent mining operations.
- Diversion of longwall manpower to other activities.
- Ventilation problems.

Development of shield and chock shield support since 1971 has significantly enhanced the mechanical strength, stability and operational capability of longwall support systems. Figure 1-1 shows some of the original roof supports assembled on a level floor in the workshop, prior to installation. Figure 1-2 shows a typical modern two-leg shield support. These shields have characteristics that overcome most of the support problems encountered in 1970/71.

1.5 LONGWALL DEMONSTRATION

Current underground mining operations are concentrated in Seam #4 using room and pillar. Mine boundaries are determined by locations at which seam inclination exceeds 15°, the practical limit for room and pillar mining.

In the initial stage of planning for No. 9G Mine in 1981, assessment of geological and geotechnical data indicated that the mine could be planned for longwall mining.

The advantages to be gained from longwall in No. 9G Mine include:

- Improved coal recovery by mining at steeper grades than currently attainable.
- Improved productivity and an enhanced competitive position in world markets.
- Improved safety through provision of a controlled mining environment.

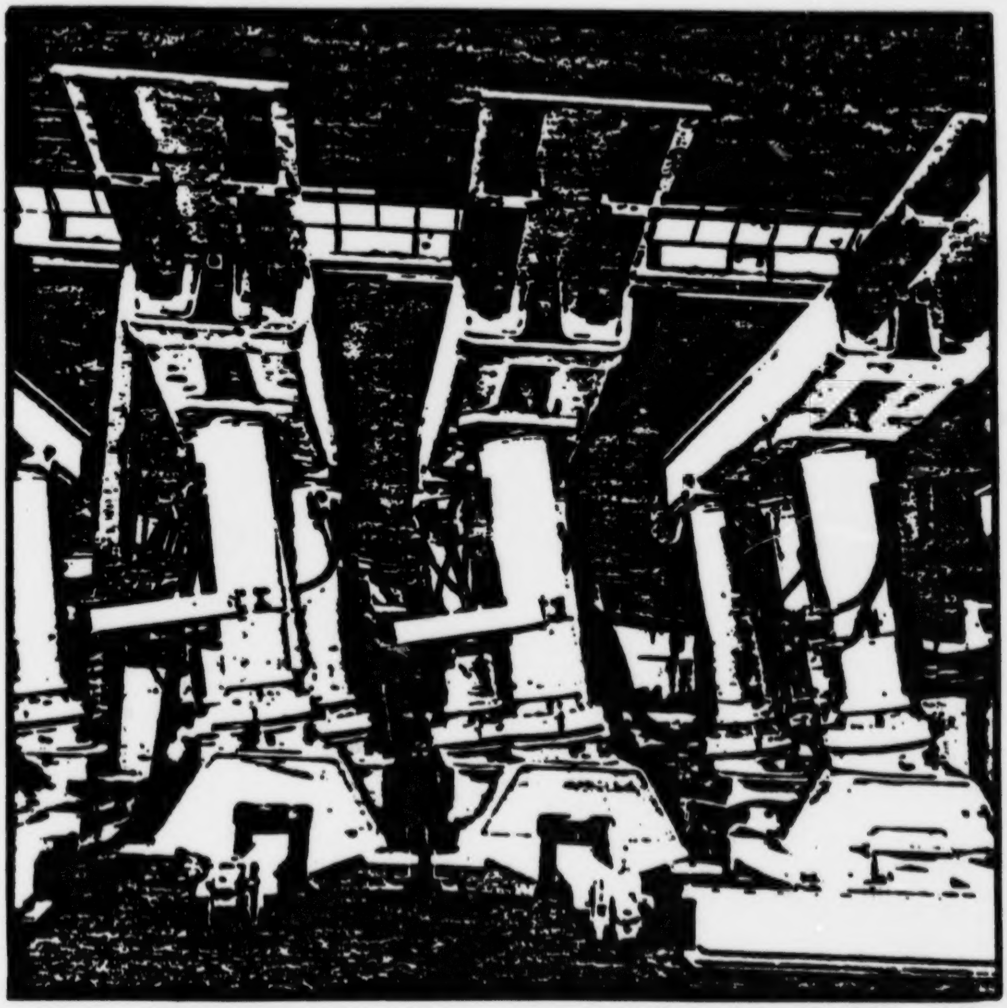
The initial costs of longwall are high, but the benefits from a successful demonstration at Smoky River would be widespread. As the operator, McIntyre would certainly benefit from the installation, but benefits would also accrue to other Canadian operators or potential operators. Since the installation at Smoky River would be unique in Western Canada it would provide an opportunity to conduct meaningful research into mining problems and provide a data base for the design of longwall systems at other Western Canadian locations.

Accordingly, McIntyre elected to enter into discussion with government and other agencies to determine how a longwall demonstration project could be organized and funded as a co-operative venture. To initiate proceedings, McIntyre issued a background paper and held discussions with CANMET personnel in Ottawa and with Alberta Government agencies. The proposal was sent to the Coal Association of Canada and the Coal Mining Research Centre in Alberta for review.

Following general acceptance of the background paper, McIntyre prepared and submitted an unsolicited proposal to CANMET to conduct a detailed feasibility study of a demonstration longwall at the Smoky River No. 9G-4 Mine.

Concurrent with submission of McIntyre's proposal, CANMET commissioned Montreal Engineering Company to assess the potential for a longwall demonstration in Western Canada. The Montreal Engineering study was submitted to CANMET on July 23 1982 and concluded that in general the site proposed by McIntyre was appropriate for a meaningful longwall trial to be conducted.

Approval to proceed with this design and engineering study was given by CANMET on September 16 1982.



NOTE: APPARENT INSTABILITY, NARROW BASE AND CANOPY, AND INCOMPLETE ROOF COVER WHEN ASSEMBLED IN THE WORKSHOP.

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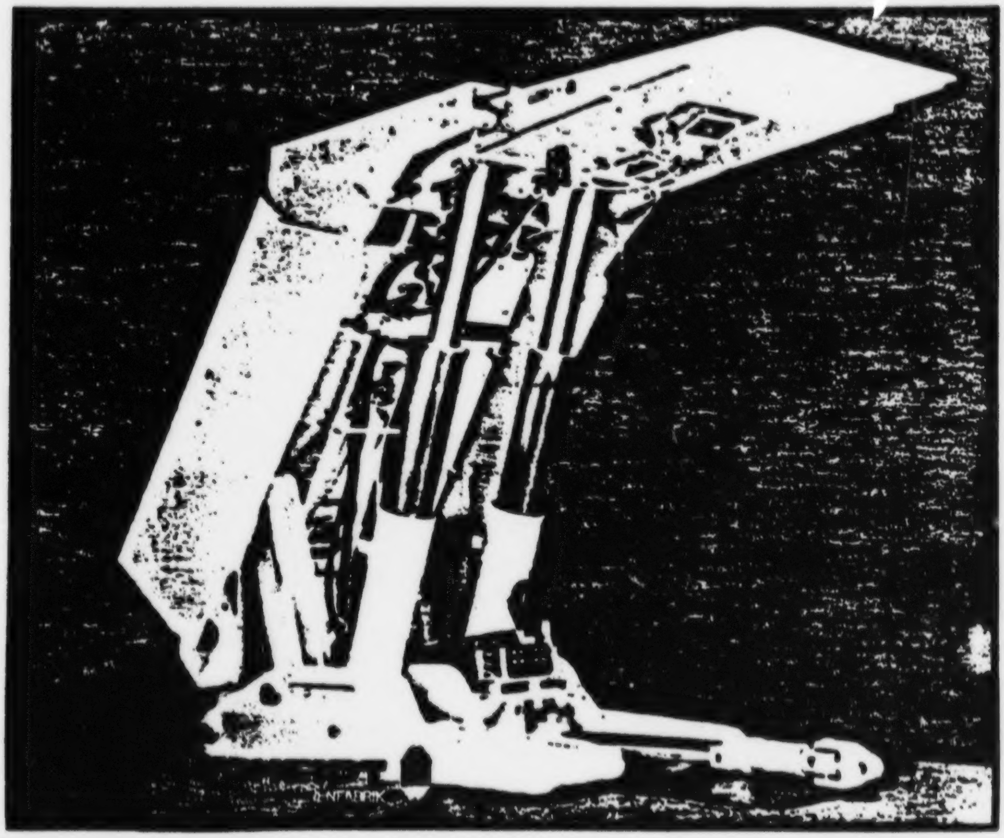
ROOF SUPPORTS - INITIAL
LONGWALL MINING APPLICATION

NOV. 1982 FIG. 1-1

Scale: N.T.S.



NOTE: WIDE CANOPY AND COMPLETE ROOF COVER
INHERENT STABILITY
WIDE BASE WITH MINIMUM POTENTIAL FOR FLOOR PENETRATION

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TYPICAL MODERN TWO-LEG
SHIELD SUPPORT

NOV. 1982 FIG. 1-2

Scale: N.T.S.

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LONGWALL DEMONSTRATION
PHASE 1

SECTION 2 SMOKY RIVER OPERATIONS

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2.0 SMOKY RIVER OPERATIONS

2.1 INTRODUCTION

Section 2 provides a description of the Smoky River operations, including a description of the No. 9G-4 Mine at its current stage of development together with the mines infrastructure and support services.

The Smoky River coalfield is located some 225 miles west of Edmonton and approximately 110 miles by road northwest of the town of Hinton, on the route of the Alberta Resources Railway (Figure 2-1). The lease area lies within Townships 57, 58 and 59, Ranges 7, 8, 9 and 10 West of the Sixth Meridian (Figure 2-2).

The production facilities at Smoky River have been established for more than ten years and have an annual capacity in excess of 2 million clean tons. More than 14 million tons of metallurgical coal have been produced and shipped since 1970. The facilities are operated by an experienced management and work force with a demonstrated production capability.

The site of the proposed longwall demonstration, No. 9G-4 Mine, is being maintained on a care and maintenance basis. Depending on decisions concerning funding and timing for a demonstration, the mine could be reactivated for longwall or room and pillar mining.

2.2 EXPLORATION AND DEVELOPMENT

2.2.1 Regional Geology

The coal in the Smoky River coalfield was deposited in a succession of interbedded marine and alluvial sandstones, siltstones and mudstones during the Lower Cretaceous Period. Subsequently these strata were tectonically deformed by folding and overthrusting along a north-westerly trending front. After general uplift the area was dissected by glacial and stream erosion along north-easterly directed valleys leaving a rugged relief of nearly 4000 ft. The general setting of this area is illustrated in Figure 2-3.

The reserves and coal quality of the Smoky River coalfield are detailed in Appendix 2-2.

2.2.2 Exploration and Development History

The Smoky River coalfield was discovered early in this century. While prospectors had been active in the Smoky River area previously the early investigations of the thick coal outcrops along the Smoky River Valley, published in 1917 were made by John McVicar in 1909 and in 1916. Testing of the coal was reported by McVicar in 1924. Numerous claims were staked and by 1926 most of these were held by subsidiary companies of McIntyre Porcupine Mines Ltd. One of these, the Blue Diamond Coal Company Ltd., carried out several geological surveys in the Smoky River/Sheep Creek district between 1926 and 1934.

Between 1959 and 1963 the US Steel Corporation carried out an exploration program under a four-year option agreement with McIntyre giving US Steel the right to acquire a certain interest in the leases. In 1963 US Steel decided not to proceed with this program. McIntyre took over the project in 1964 and after detailed studies in 1967 initiated a development plan for No. 2 and No. 5 Mines along the Smoky River. The locations of these are shown in Figure 2-3 which shows the mine areas within the coalfield.

Between 1964 and 1968 McIntyre commissioned studies by Mitsubishi Mining Company of Japan and the Paul Weir Company of Chicago which led to the completion of overall feasibility studies for the development of the property.

Exploration work was undertaken in the following areas:

- Mine 5: Geologic mapping and one drill hole near Flood Creek, M. Inoue 1967-69.
- Mine 7: Drilling during 1968-69 and again in 1975 and 1981 in the Fox Creek and Campbell Flats area.
- Mine 9: Exploration in 1969-70 and extensive drilling in 1972-73 outlined extensive surface mineable coal deposits. Recent exploration work has been concentrated in this area to outline the underground mines adjacent to the open pit operations, No. 9A, No. 9B, No. 9C and No. 9G Mines. The work continued throughout 1981.
- Mine 10: Drilling at Beaverdam site in 1970.
- Mine 3: Drilling in 1970 and again during 1973-74.
- Mine 8: Initial exploration in the McEvoy and Barrett areas in 1970.
- Mine 2: In 1972, Seam #11 in this area was considered as the site for a conveyor system from Sheep Creek to the Smoky River plant site. The area around the Sheep Creek portals was explored by drilling.

2.2.3 Mining Areas

The Smoky River coalfield is divided into mine areas by geologic structures and deeply eroded river valleys (Figure 2-3).

The Winder Syncline, located between the Barrett and McEvoy Anticlines, contains No. 5 Mine east of the Smoky River, and No. 2 Mine between the Smoky River and Sheep Creek. No. 9 Mine lies west of Sheep Creek on the McEvoy and Barrett Anticlines and the intervening Winder Syncline. No. 8 Surface Mine was located on the crest of the McEvoy Anticline between the Smoky River and Sheep Creek and a limb of the Barrett anticline.

Mining operations to date have been restricted to the fault slice between the Muskeg and Mason Thrusts. Other fault blocks, overthrust from the southwest, bring the coal bearing strata above the Smoky River Valley bottom.

2.3 INFRASTRUCTURE

2.3.1 The Alberta Resources Railway

McIntyre's requirement for rail services coincided with the interest of the Alberta Government in providing a rail connection between the Grande Prairie area and the CNR main line in the Hinton-Jasper area. The provincial government had decided that it was in the best interests of the province to promote and provide this railway facility, and that the railway would have to precede development of the Smoky River operation. The Provincial Government decided to finance construction of the Alberta Resources Railway, which CNR would construct and operate, and announcement of the decision to proceed with construction of the

Alberta Resources Railway was made in the Provincial Legislature on February 18 1965.

In early 1966 McIntyre negotiated with the CNR and a firm contract was signed in April 1970.

2.3.2 The Town of Grande Cache

Planning for the Town of Grande Cache began in 1966. Basic plans were predicated on an initial population of 4000 with an ultimate population in the order of 5000. The cost of establishing the town was borne largely by the Provincial Government and McIntyre contributed to the costs of housing, a recreation complex and a hospital.

Site clearing started in 1968 and the first houses were ready for occupancy in late summer 1969. As the town presently exists it has all modern services including schools, a hospital, stores, hotels and motels, service stations and a recreation complex.

2.4 OPERATIONS AT SMOKY RIVER

2.4.1 Coal Production

A letter of intent concerning a long-term coal supply agreement was signed by McIntyre and Nippon Kokan Kaisha in August 1968. The content was finalized in January 1969 to provide for delivery of 1 million tons of metallurgical coal from the Smoky River property to Japan commencing in 1970 and increasing in 1971 to 2 million tons per annum for a total coal delivery of 29.5 million tons over the 15-year agreement.

Construction at Smoky River was essentially completed in the third quarter of 1970 and underground development in No. 2 Mine and No. 5 Mine started in 1969 based on longwall mining layouts. Initially a shortage of qualified miners and equipment allied with plant start-up troubles resulted in failure to meet scheduled production. Both longwall units failed to perform effectively and were withdrawn in July 1971, being replaced by room and pillar methods using continous miners. To alleviate the shortfall in underground production No. 8 Surface Mine was started in the third quarter of 1971.

In January 1973 No. 5 Mine was closed and production from No. 8 Surface Mine was increased. Also during 1973 No. 9 Surface Mine was developed to replace production from No. 8 Mine and reached rated production in the final quarter of 1974.

In April 1973 the long-term coal supply agreement between McIntyre and the Japanese Steel Mills was replaced by a one-year contract providing for delivery of 1.25 million tons.

During the latter part of 1974 a three-year coal supply agreement was concluded with the Japanese Steel Mills providing for deliveries of 1.5 million tons annually commencing in April 1975.

Contractual deliveries of coal to the Japanese Steel Mills were reduced by the agreement of March 1978 to 800 000 tons per annum. A two-year agreement providing for 800 000 tons per annum was concluded in March 1979 and in March 1981 a further two-year agreement to supply 1.2 million tons per annum was concluded.

Negotiations with the Japanese Steel Mills concluding in late 1982, resulted in a contract agreement to supply a total of 1.8 million tons between October 1982 and April 1984.

In 1979 operations resumed in No. 5 Mine (Seam #4) and a new underground mine No. 9A (Seam #4) was opened off the highwall of No. 9 Surface Mine. Production increased from less than 1 million tons in 1979 to a record high of almost 2.1 million tons in 1981 to meet demands from Japan for increased shipments to offset shortfalls in deliveries from other suppliers. Production from No. 9 Surface Mine made up 69% of this total.

Table 2-1 summarizes raw and clean coal production from the Smoky River operation from 1970 through 1981 showing the proportions of raw coal mined by surface and underground methods.

2.4.2 Surface Mines

Presently there is one surface mine at Smoky River, No. 9 Mine which has been in operation since 1973. No. 9 Mine is located in mountainous terrain on the north side of Sheep Creek, approximately 7 miles from its junction with the Smoky River (Figure 2-4). The mining method is conventional truck and shovel.

Waste is hauled to dumps located outside potential mining areas or is used to backfill previously mined out areas. Outside the pit areas waste haulage is usually downhill on an 8% grade.

Coal is trucked to a breaker station at Sheep Creek approximately 5 miles from the open pit operations. From the breaker station the coal is conveyed to the coal preparation plant by a tunnelway conveyor through the mountain.

No. 9 Mine has fully equipped maintenance facilities with a total floor area of 43 000 sq ft and is centrally located approximately one mile east of the present open pit.

Power, water and waste treatment systems have been established for the surface mine operations and will be capable of satisfying all future demands of the mine without any major additional capital expenditures.

Power is transmitted to the mine at 25 kV then stepped down at four different substations to 4160 volts before supplying power via trailing cables to the shovels.

2.4.3 Underground Mines

At present there are two underground mines developed in Seam #4, No. 9G-4 and No. 9A-4 Mines. The locations are shown in Figure 2-4. The entrances to No. 9G-4 Mine are located approximately 0.8 miles to the northeast of the open pit workshop and facilities area (Figure 2-5). A detailed description of No. 9G-4 Mine and mining operations is provided in sub-section 2.6.

The entrances to No. 9A-4 mine are located approximately 0.5 miles due west of the open pit workshop area. Access to Seam #4 has been made by driving three headings into the seam from the highwall of the open pit workings. The seam thickness varies from 19.5 to 22 ft with the working section being the top 10 to 12 ft of the seam.

The mine has been developed a distance of 5000 ft along strike to an arbitrary mine boundary. Retreat pillaring operations are now underway and reserves within the present mine boundary will be exhausted in the last quarter of 1983. Coal reserves are all in the proven category and overall recovery is projected as 45% of the mineable in situ reserves.

The mine is ventilated by four 54 inch Engart fans which produce an airflow of 240 000 cfm when operating at a pressure of 3 inch WG. The emission level of methane is low.

Coal is mined by continous miners loading to Joy shuttle cars which deliver via a breaker feeder to a main 42 inch wide belt conveyor. The main conveyor system delivers coal to a radial arm stacker conveyor on the surface capable of stockpiling up to 2000 tons. The coal is loaded by front-end loaders into 50-ton trucks which transport the coal some 4.5 miles to the Sheep Creek breaker station.

The total number of hourly paid underground workers employed at No. 9A-4 Mine is 71 with a supervisory and engineering staff of 14.

Three potential mines exploitable by current underground methods have been identified. These are No. 9B-4, No. 9C-4 and No. 7 Mine (Figure 2-6).

No. 9B-4 Mine area is located approximately 1.5 miles west of the open pit workshop area. The geology of the area has been well defined by drilling and the proven reserves have seam gradients from 11° to 14°. The total recoverable reserves in the mine area are 2.7 million tons. Additional recoverable reserves are available at steeper gradients.

No. 9C-4 Mine area is an extension of No. 9B-4 Mine. Available information indicates seam gradients at 5° to 15°. Additional exploration will be required to upgrade reserves to the proven category. Total recoverable reserves are 4 million tons. Additional recoverable reserves are available at steeper gradients.

No. 7 Mine is located in a virgin area and significant capital expenditure would be required to establish the necessary infrastructure and transportation corridors. A Preliminary Disclosure has been approved by the Provincial Government as the first stage in the mine development process. Exploration conducted in 1981 identified 10 million tons of coal in Seam #4 and 5 million tons in Seam #3 in the proven category. The seams are generally flat lying under relatively shallow cover and are considered of high potential for underground mining.

2.5 PRINCIPAL SURFACE FACILITIES

The principal facilities which serve both surface and underground mines are shown in Figure 2-7.

2.5.1 Raw Coal Transportation

The main components of the raw coal transportation system are the tunnel conveyor system and a fleet of Caterpillar 773 and 777 trucks. The tunnelway transports coal from both surface and underground mines.

Completed in 1975, the system consists of a 48 inch conveyor which discharges approximately 0.5 miles inbye from the Seam #11 Sheep Creek entries onto a 1.5 mile 60 inch conveyor. Interconnecting conveyors lead from the Sheep Creek breaker station to the Seam #11 Sheep Creek entries and similarly from the Smoky River entries to the preparation plant raw coal stockpile. The speed of all conveyors is 620 fpm. The rated capacity of the Smoky River section of the system is 2250 tons per hour and that of the Sheep Creek section is 1400 tons per hour.

Coal from both surface and underground mines is loaded by front-end loaders into trucks and delivered to the Sheep Creek breaker station.

2.5.2 Coal Preparation Plant

The coal preparation plant and related facilities are shown in Figure 2-7. Run-of-mine coal is reclaimed from the pre-plant stockpiles and conveyed to the plant breaker station and screen-house for sizing. The raw coal is then fed to the plant via an 1800 ton capacity silo.

The coal is processed in two size fractions:

- Coarse coal (+28 mesh) in heavy-medium cyclones.
- Fine coal (-28 mesh) by flotation.

Clean coal is mechanically and thermally dried and then conveyed to two storage silos of 6700 ton capacity or to open stockpile. Product coal is reclaimed from storage onto a unit train flood-loading system.

Coarse reject is separated into two fractions at 3/4 inch and the undersize conveyed to the adjacent Albert Power Limited Milner Plant as fuel. Oversize reject is trucked to disposal areas. Flotation tailings can be mechanically and thermally dried and then conveyed to the Milner Plant. Alternatively the tailings can be transported hydraulically to impoundments on the south side of the Smoky River.

Facilities associated with the preparation plant include an analytical laboratory, magnetite storage, process water distribution system and necessary utilities.

2.5.3 Service Complex

The service complex includes offices, deployment centre, mine dry, workshops and warehouse, all of which have capacity to support the level of output envisaged for the Smoky River operation. All these facilities were constructed in 1969/70 and are in good operating condition.

2.5.4 Utilities

The Smoky River operation is fully serviced with modern utilities.

The site is connected to the Northern Alberta grid system of Alberta Power Limited. Two overhead electric power line systems feed power to the site at 138 kV. The Milner Plant supplies power to the Northern Alberta grid via these lines. In the unlikely event of failure of both lines the Milner Plant could supply power directly to the Smoky River operation.

Incoming power is fed into a central substation adjacent to the preparation plant then distributed at suitable stepdown voltage to all parts of the site. Power for the No. 9 Mine area is transmitted via an overhead line at 25 kV. A 1 MW stand-by generator is available to supply emergency power to essential services.

The site is supplied with natural gas by a pipeline from North Western Utilities' North Western Alberta distribution system. Natural gas is used for most space heating and as fuel for the thermal dryer at the preparation plant. In the event of a prolonged supply interruption the preparation plant could not operate but run-of-mine coal can be stockpiled to allow mining operations to continue. Should the interruption occur in winter underground operations could continue as ventilating air is heated by propane-burning equipment.

At the preparation plant a main distribution system carries process and fire-fighting water to all facilities. Water is supplied from a pumphouse which draws from the Smoky River and an adequate quantity of water is available. The pumphouse is supplied automatically with stand-by electrical power in the event of interruption.

A well located near the mine office supplies domestic water for the preparation plant. The water is softened and chlorinated before being distributed in a separate main system. Domestic water in the No. 9 Mine area is supplied from wells.

2.5.5 Waste Water

All domestic waste from facilities at the preparation plant is processed through a sewage treatment plant before discharge into the Smoky River. A series of settling ponds are used to clarify all run-off from the preparation plant before discharge into the Smoky River. The ponds are constructed such that they can be cleaned out periodically.

All discharges into the river are monitored for compliance with provincial effluent discharge standards.

2.5.6 H.R. Milner Power Plant

The Milner Plant was built by Alberta Power Limited about one year after the Smoky River main facilities. The plant operates on several fuel streams: dewatered tailings, the minus 3/4 inch fraction of preparation plant dense medium circuit coarse rejects, oxidized or low quality coal, and natural gas. The Milner Plant effectively disposes of all potentially usable waste products and supplies power not only to the Smoky River operation and the town of Grande Cache but to a regional power grid serving North Central Alberta. Fly-ash from the Milner Plant is trucked to a disposal site at Flood Creek.

2.6 THE NO. 9G-4 MINE

2.6.1 Surface Facilities

The site of the proposed longwall demonstration is No. 9G-4 Mine. The mine portals are located in mountainous terrain on the north side of Sheep Creek approximately 7 miles from its junction with the Smoky River and approximately 0.8 miles to the northeast of No. 9 Mine's surface facilities (Figure 2-5).

Access and Transportation

A 60 ft wide all-weather mine road extends from the service complex/ preparation plant to the No. 9 Surface Mine area. A roadway of similar standard has been constructed from No. 9G Mine to intersect this road as shown on Figure 2-5. The road system can accommodate the transportation of large and heavy items of equipment associated with mining activity. The only restriction on transportation on this road is the bridge across Sheep Creek which has a width limitation of 13 ft and maximum safe load of 70 tons.

Underground employees are transported between the minesite and Grande Cache by bus. Senior supervisory and maintenance personnel are provided with suitable vehicles for operation on mine roadways.

Roadway Maintenance

The total transportation requirements for combined surface and underground mining operations will remain largely unchanged from current levels. The existing fleet of roadway maintenance equipment will be retained and no difficulties are anticipated.

Structures

No. 9G-4 Mine's adjacent surface facilities are largely constructed on fill provided from surface mining operations. The area is properly drained and all effluent discharge is treated to comply with provincial requirements.

The facilities are comprehensive and, when combined with the adjacent surface mine workshop facilities, are adequate to support longwall development and operations. Additional office facilities for research projects can be readily provided.

The existing surface facilities at No. 9G-4 Mine (Figure 2-8) include:

- A combined bathhouse, change rooms, lamproom, manpower deployment and office facility. The facilities can accommodate a total of 150 persons. Office facilities are provided for senior management, supervisory and maintenance staff.
- Water storage, softening and heating facilities of adequate capacity to service the bathhouse complex and workshops.
- Propane storage of adequate capacity to provide heating to the bathhouse complex, workshops and mine air heating system.
- An electrical substation and distribution complex to provide power for both surface and underground operations.
- A two-bay service building suitably equipped for routine servicing and maintenance of diesel powered supply vehicles.
- A three-bay service building suitably equipped to allow routine servicing and maintenance of electrical and mechanical equipment in separate bays. The third bay is used as a covered storage area for equipment spares and materials such as lubrication oils and greases.
- A portal building located adjacent to the main conveyor drive to accommodate the conveyor attendant, allow searches for contraband materials and register personnel in the mine.
- The main trunk conveyor drive and delivery unit which discharges coal to an 8000 ton capacity stockpile.
- Main ventilating fans, airlock and access for supplies. The ventilation facility is so constructed that the capacity of the sys-

tem can be readily increased by the installation of additional fan units or a larger capacity single unit.

- An area adjacent to the mine portals designated as a stockyard for items of equipment routinely consumed in mining operations, i.e. timbers, roof bolts, etc. The stockyard is designed to allow unobstructed access to stocked items for both trucks and underground supply vehicles.
- A propane-fired air-heater installed between the two mine entrances to ensure that the air temperature in the underground mine remains at a reasonable level and to prevent icing conditions in the main intake. Appropriate flame monitoring protection devices are incorporated in the heater control systems.
- An area available to accept large stores items for trans-shipment to supplies vehicles for transportation underground.

Power Supply

The main power supply is obtained from a substation at the Milner Plant. In the event of a shutdown of the Milner Plant, power requirements can be met by importing power from the grid system. Power is distributed by overhead line to the mines at 25 kV. A simplified schematic diagram is shown in Figure 2-9.

At the mines voltage is stepped down to 6.6 kV for underground distribution and to 550 volts for surface distribution and utilization. Surface lighting and office power supplies are obtained from a separate transformer source.

Where continuity of supply is essential as for firefighting pumps a separate stand-by diesel generator is provided.

Communications

An automatic electronic switchboard and telephone system has recently been installed at the main office. Communication with the No. 9G-4 Mine is achieved through a 100 channel microwave link. This combined system allows communication between any pair of telephones installed throughout the property both at the surface and underground. The microwave system can be used with suitable interface equipment to transfer data between selected locations.

Staff vehicles are equipped with mobile radios.

To improve reporting and recording procedures and to assist in the resolution of production problems a central control room has been established. In the event of an incident the control room, which is manned on each shift including weekends, would assume a clearly defined co-ordination role. The control room is equipped with three telephones each on a separate line and a radio receiver/transmitter capable of operating on all frequencies in use at the mine.

Water Supply

An adequate water supply is available for dust suppression, firefighting and bathing facilities.

Water in the No. 9G-4 Mine area is available from wells and from within the mine. Measurements of water quantities from existing sources show that approximately 90 gpm are continuously available for all uses.

This is adequate when used in conjunction with a pump and water storage system to provide the necessary water requirement.

Propane

Propane has been successfully used at Smoky River for many years, as a fuel for space heating in buildings, water heating for bathhouse facilities and mine air heating.

Propane storage tanks and vapourizing equipment of adequate capacity to satisfy the total anticipated demand are installed at the mine surface. They are enclosed in a locked compound and surrounded by safety berms to prevent migration of liquid propane in the event of tank failure. The volume of propane contained in the tanks is routinely monitored and when necessary additional propane is delivered to the site by tanker truck.

Coal Clearance

The equipment fleet for loading and transporting coal from stockpiles operates under the control of the Surface Mine Manager. Fleet capacity when operating from No. 9 Surface Mine and No. 9A-4 and No. 9G-4 Underground Mines is in excess of 8000 tons daily. No problems of stockpile clearance are anticipated.

First Aid

First aid facilities are housed in the administration building and include treatment and rehabilitation areas. An ambulance service is provided and trained personnel man the facility on a continuous basis.

Engineering

In addition to the mining operations group an engineering section provides services such as mine planning, ventilation measurement and control, dust sampling, surveying, etc. These services will be continued and where necessary additional support staff will be provided.

2.6.2 Current Status

Two cross-measure drifts supported by steel arches have been driven in No. 9G-4 Mine to intersect Seam #4. The drifts are 1100 ft long and dip at 7°. One drift is used as an intake airway and accommodates the main trunk conveyor system. The second drift is used as a return airway and provides access for material and supplies. A substantial airlock has been constructed and accommodation for the main ventilation systems is provided.

From the point of intersection with the coal seam further development has taken place in-seam, with roof support by roof bolting.

At the point of intersection of the coal seam and access drifts there is a change of gradient from 7° dipping to 12° rising. This forms a natural low point in the mine and a water sump and pumping station has been constructed adjacent to this location. Any water inflow from Seam #10 and inbye workings will be directed to this sump area and pumped to the surface.

Because of the change in grade this roadway could present an obstacle to the transportation of large items of mining equipment and an alternative transportation route for longwall equipment has been considered in Section 5.

Development within the mine has been conducted with conventional room and pillar mining equipment and the extent of current development is shown in Figure 2-10.

Roadways 20 ft wide by 10 ft high spaced at 110 ft centre to centre have been driven. Where possible, crosscuts at 200 ft centres have been constructed at 90° to the development roadways to form square junctions. This has reduced the size of junctions and consequently the area of roof to be supported. The pillars of coal left in this configuration are capable of providing adequate support to the strata above the seam.

Roof support is achieved using roof bolting equipment to drill 1 7/8 inch diameter holes and setting 6 ft long mechanically anchored bolts. A 3 inch square wire mesh supported by the roof bolt plates covers the total exposed roof area. Side support is achieved with wooden props and planks.

In order to assess the likely conditions along a typical longwall face-line Roadway A was driven approximately 600 ft (Figure 2-10).

In this section of roadway:

- Methods of supporting the roadway sides using wooden and epoxy resin dowels were tested.

- A site for testing floor strengths was prepared by extracting the full seam section to allow tests at various horizons in the coal seam to be conducted by the Coal Mining Research Centre.
- Core samples of the immediate strata above and below the coal seam were obtained for testing by Seegmiller International.

Before production was suspended at No. 9G-4 Mine, following a reduction in market demand, three sets of continuous mining equipment were in use. At the present time the mine is on a 'care and maintenance' basis. Ventilation and pumping are maintained and, where necessary, roadway repairs are effected to ensure that the mine can readily be returned to production status.

TABLE 2-1

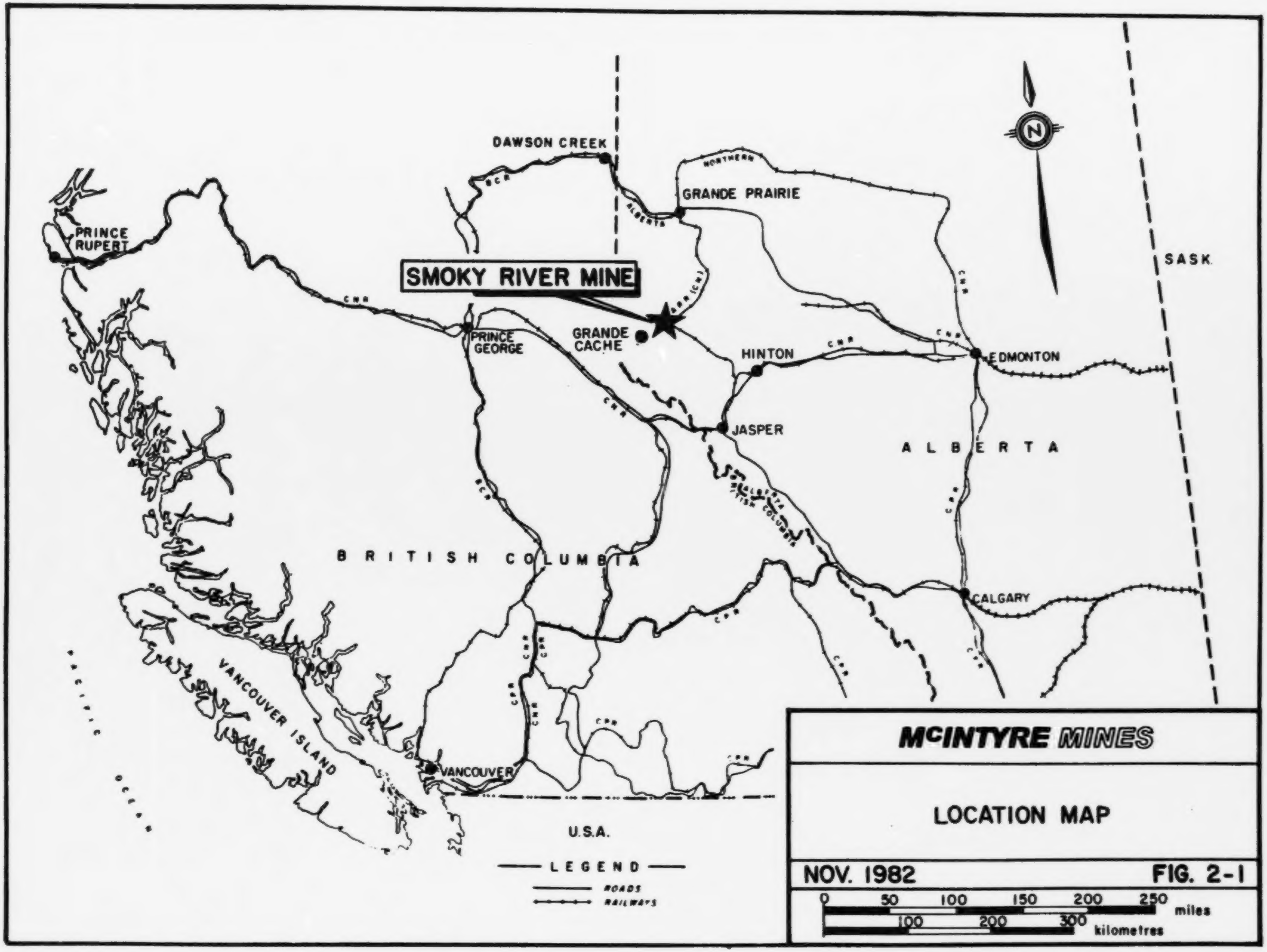
McINTYRE MINES LIMITED

TOTAL PRODUCTION BY SOURCE

	RAW COAL (Thousands of Long Tons)	CLEAN COAL (Thousands of Long Tons)	UNDERGROUND (%)**	SURFACE (%)**
1970	977	420*	100	0
1971	1,993	1,178	82	18
1972	2,533	1,566	58	42
1973	2,087	1,442	39	61
1974	2,358	1,528	32	68
1975	2,588	1,680	30	70
1976	3,162	1,865	35	65
1977	2,944	1,740	43	57
1978	2,131	1,316	58	42
1979	1,755	1,044	64	36
1980	2,329	1,470	47	53
1981	3,108	2,076	31	69

* Excludes coal processed through temporary cleaning plant.

** Raw coal basis.

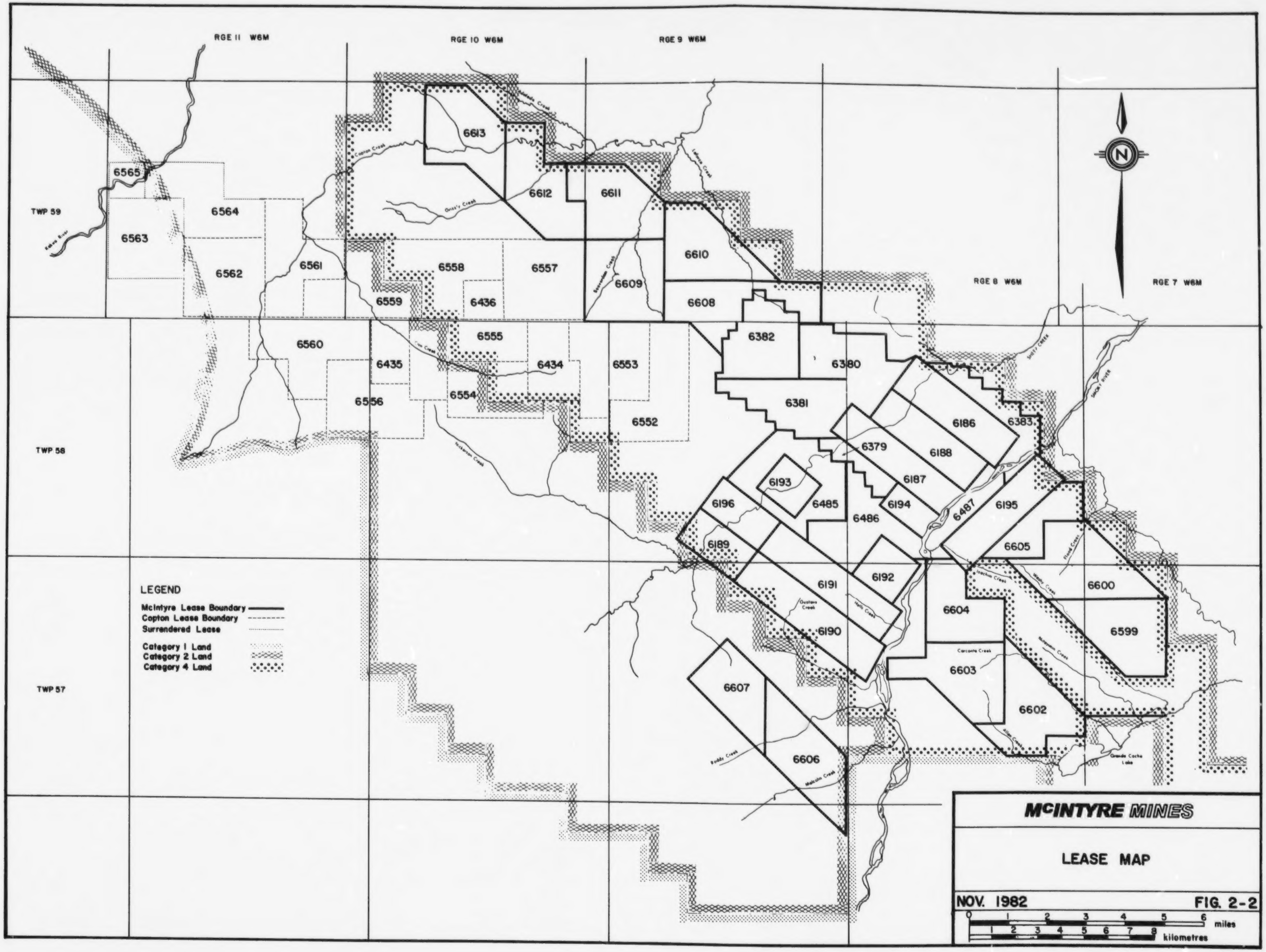


McINTYRE MINES

LOCATION MAP

NOV. 1982

FIG. 2-1

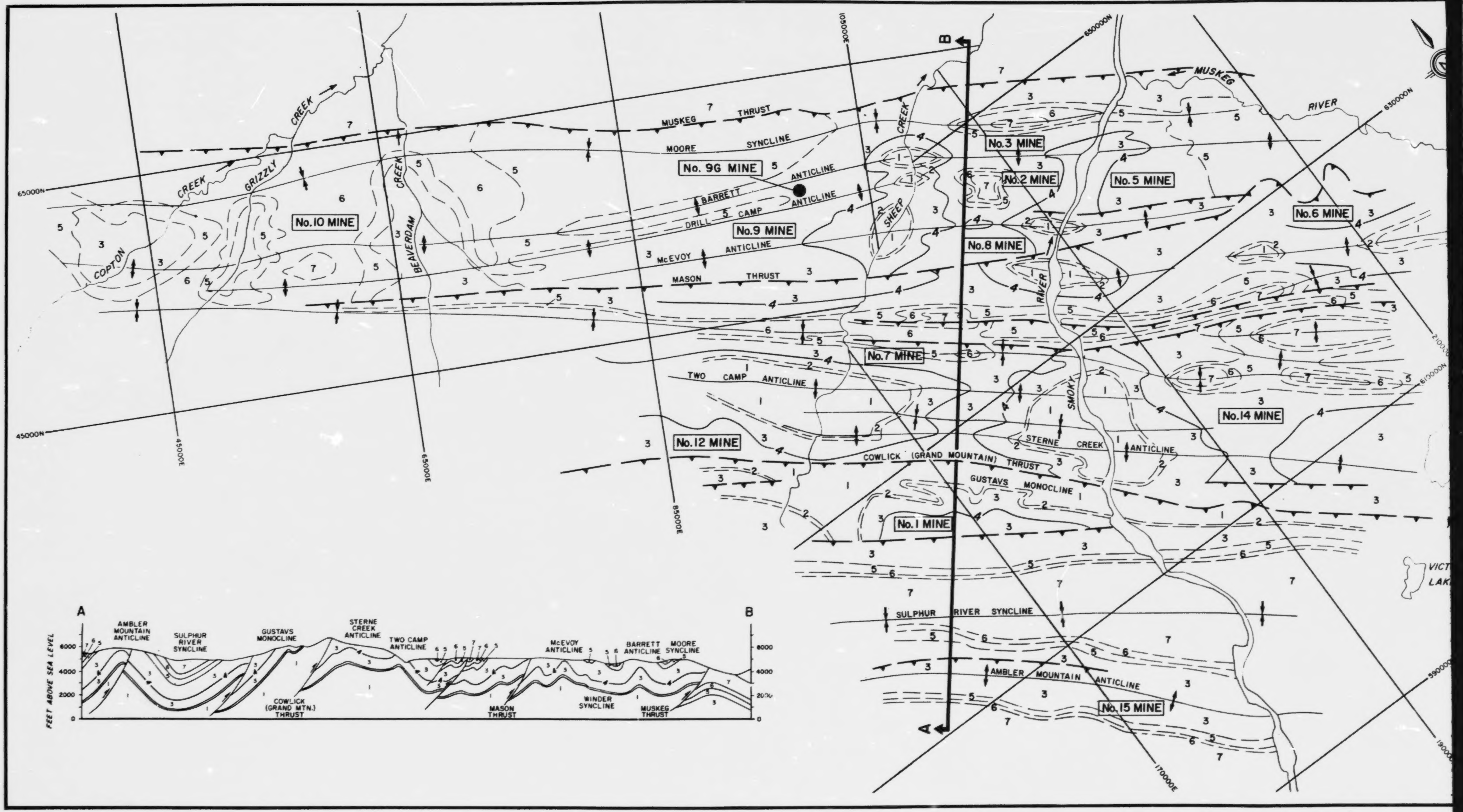


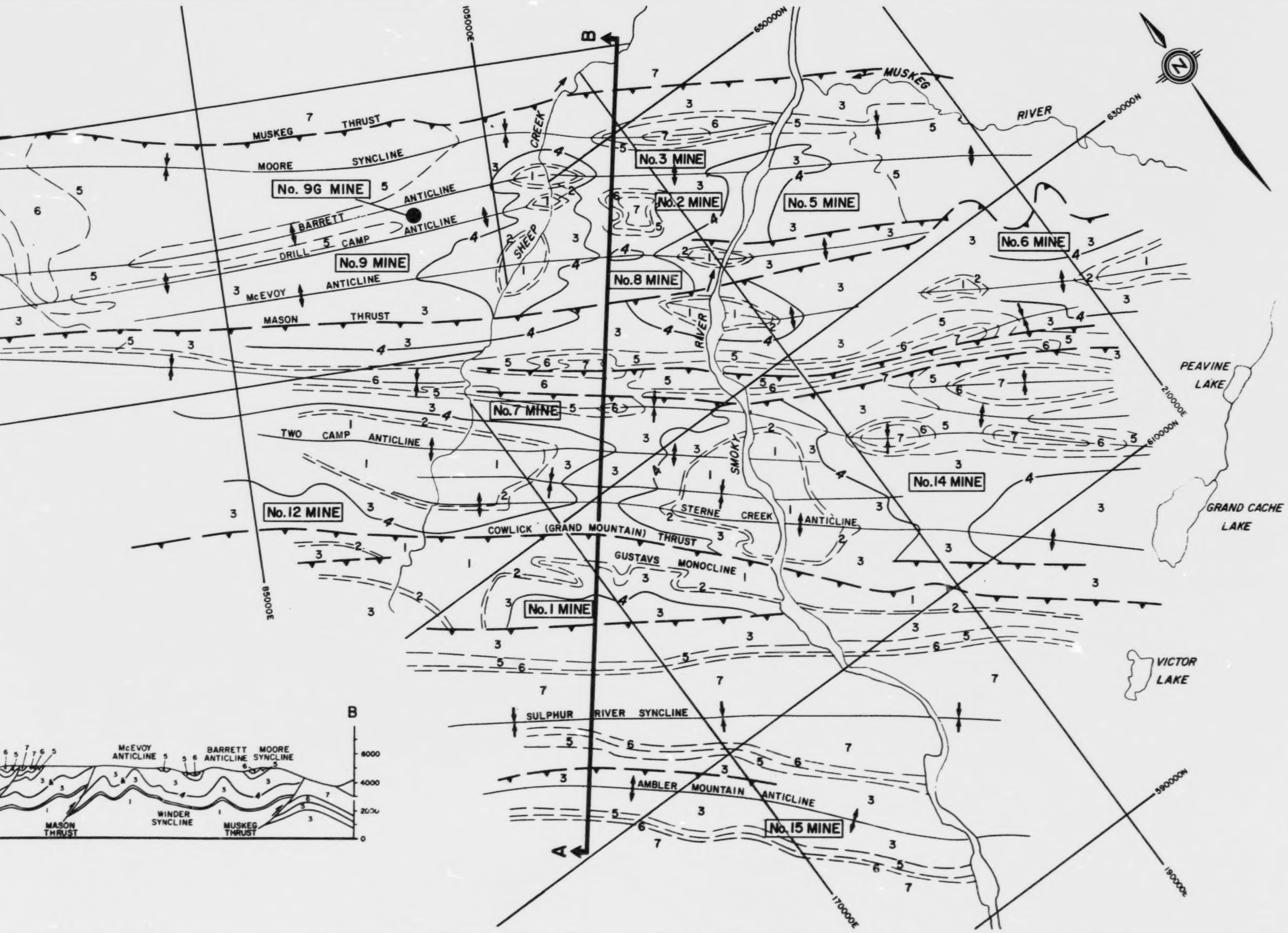
McINTYRE MINES

LEASE MAP

NOV. 1982

FIG. 2-2


MUSKEG THRUST
MOORE SYNCLINE
BARRETT ANTICLINE
DRILL CAMP ANTICLINE
McEVOY ANTICLINE
MASON THRUST
TWO CAMP ANTICLINE
STERNE CREEK ANTICLINE
COWLICK (GRAND MOUNTAIN) THRUST
GUSTAVS MONOCLINE
SULPHUR RIVER SYNCLINE
AMBLER MOUNTAIN ANTICLINE
No. 1 MINE
No. 2 MINE
No. 3 MINE
No. 5 MINE
No. 6 MINE
No. 7 MINE
No. 8 MINE
No. 9 MINE
No. 9G MINE
No. 10 MINE
No. 12 MINE
No. 14 MINE
No. 15 MINE
COPTON CREEK
GRIZZLY CREEK
BEAVERDAM CREEK
SHEEP CREEK
SMOKY RIVER
MUSKEG RIVER
VICT
LAK
65000N
45000N
45000E
65000E
85000E
105000E
650000N
630000N
610000N
590000N
170000E
190000
210000
A
B
FEET ABOVE SEA LEVEL
6000
4000
2000
0
8000
4000
2000
0
AMBLER MOUNTAIN ANTICLINE
SULPHUR RIVER SYNCLINE
GUSTAVS MONOCLINE
STERNE CREEK ANTICLINE
TWO CAMP ANTICLINE
McEVOY ANTICLINE
BARRETT ANTICLINE
MOORE SYNCLINE
COWLICK (GRAND MTN.) THRUST
MASON THRUST
WINDER SYNCLINE
MUSKEG THRUST



LEGEND

UPPER CRETACEOUS

7	KASKAPAU FORMATION: SHALE, SANDY SHALE, MINOR IRONSTONE, SANDSTONE (MARINE)
6	DUNVEGAN FORMATION: SANDSTONE, SANDY SHALE (MARINE & ALLUVIAL)

LOWER CRETACEOUS

5	FORT ST. JOHN GROUP: SHALE, SILTY SHALE, MINOR SANDSTONE (MARINE)
3 4 3	LUSCAR FORMATION: SANDSTONE, SHALE, CARBONACEOUS SHALE, MINOR CONGLOMERATE, COAL SEAMS (ALLUVIAL) #4 SEAM SHOWN
2	CADOMIN FORMATION: CONGLOMERATE, MINOR SANDSTONE (ALLUVIAL)

LOWER CRETACEOUS AND UPPER JURASSIC

1	NIKANASSIN FORMATION: SANDSTONE, SANDY SHALE, CARBONACEOUS SHALE, (MARINE AND ALLUVIAL)

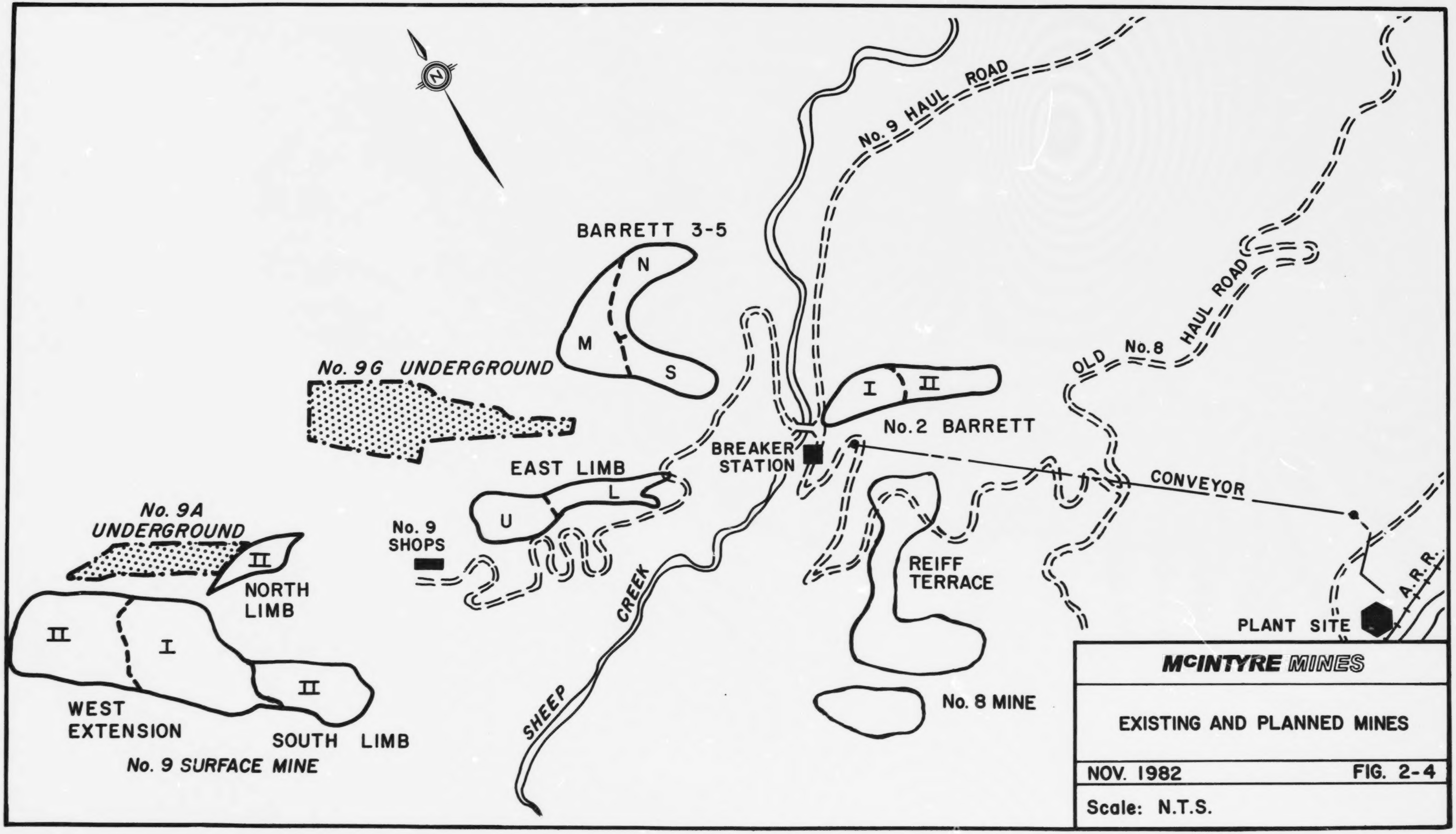
McINTYRE MINES

GEOLOGICAL SKETCH MAP OF THE SMOKY RIVER COAL FIELD

NOV. 1982

FIG. 2-3

0 5000 10 000 15 000 20 000 feet
2 000 4 000 6 000 metres



McINTYRE MINES

EXISTING AND PLANNED MINES

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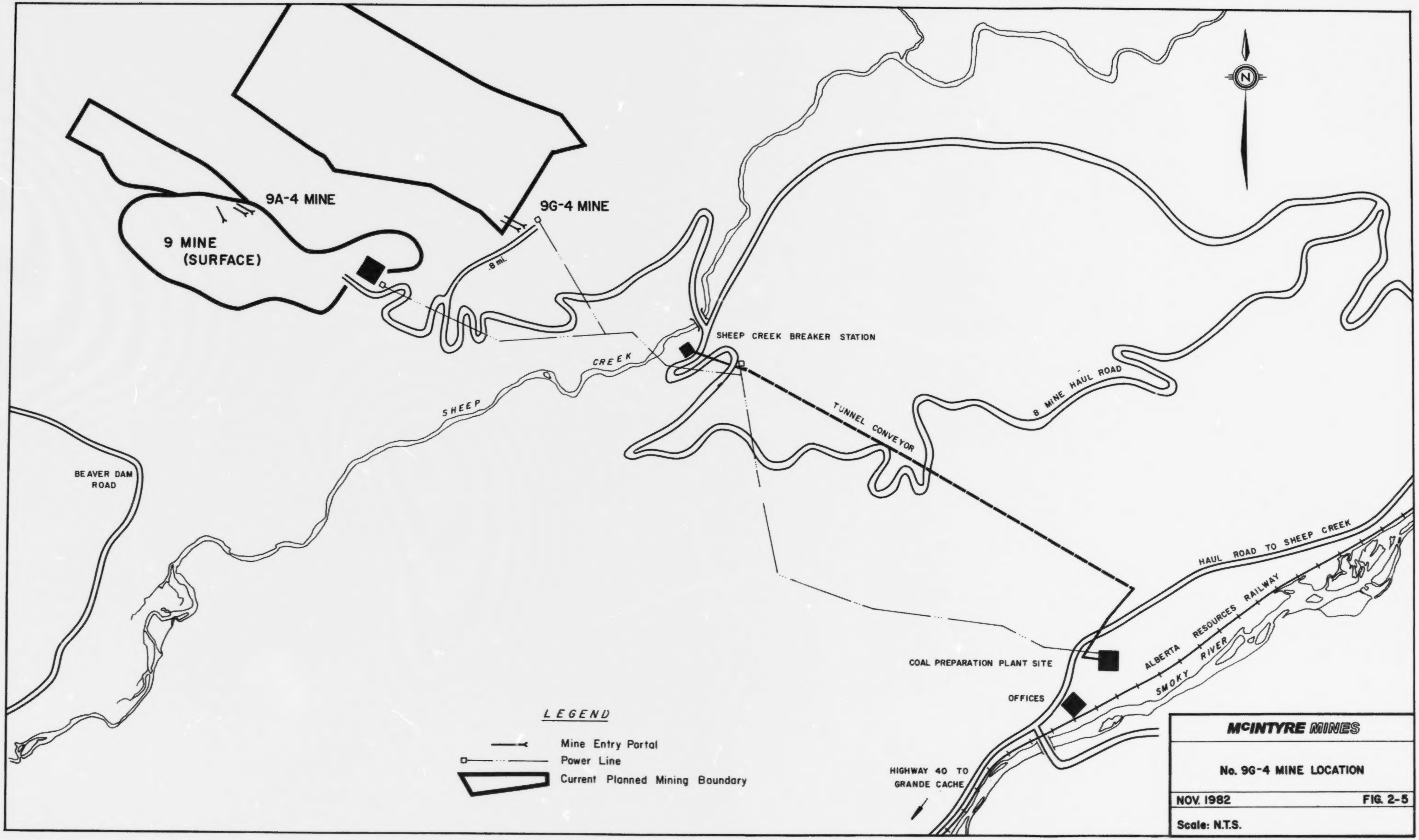
FIG. 2-4

Scale: N.T.S.



McINTYRE MINES

No. 9G-4 MINE LOCATION

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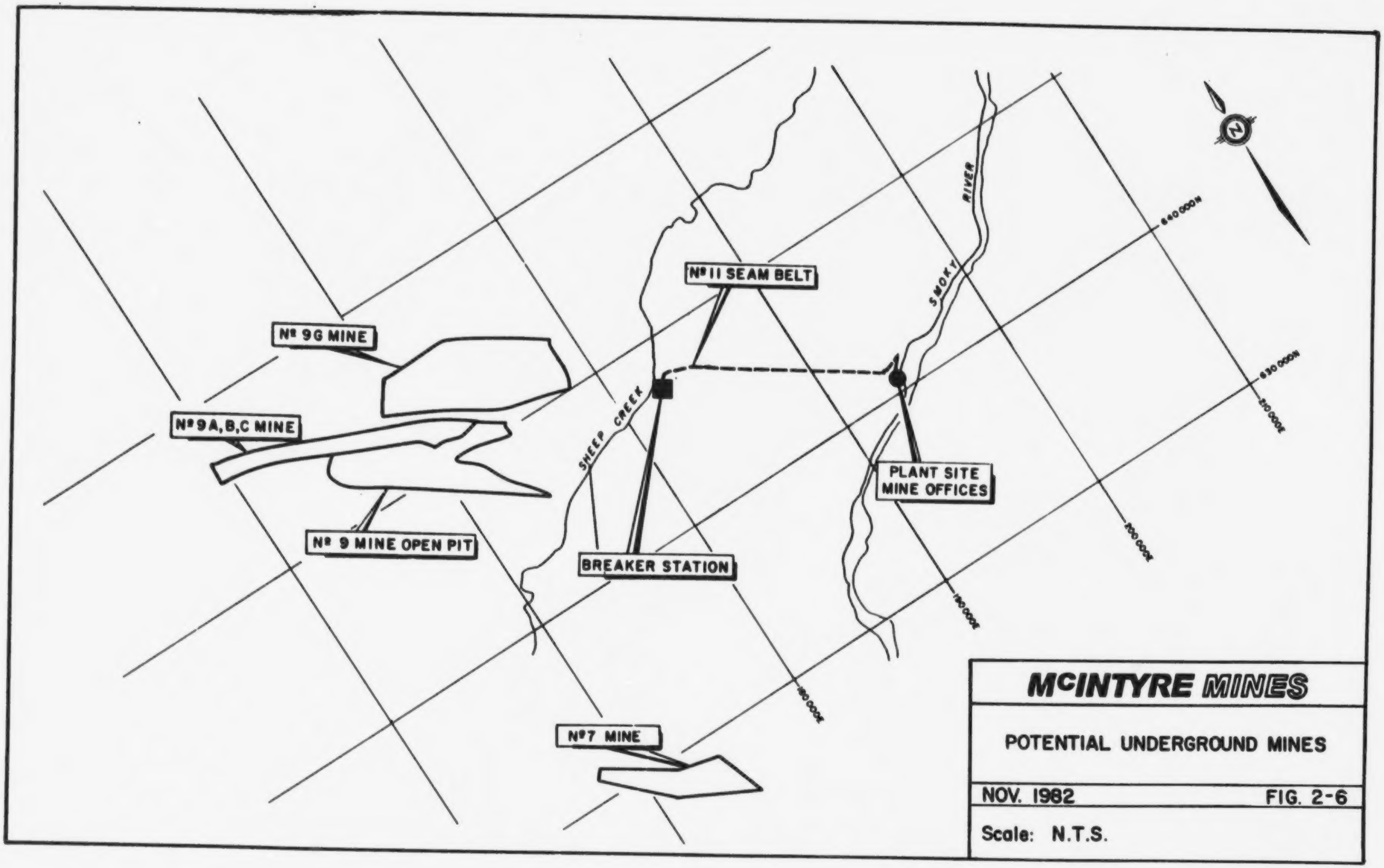
FIG. 2-5

Scale: N.T.S.



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POTENTIAL UNDERGROUND MINES

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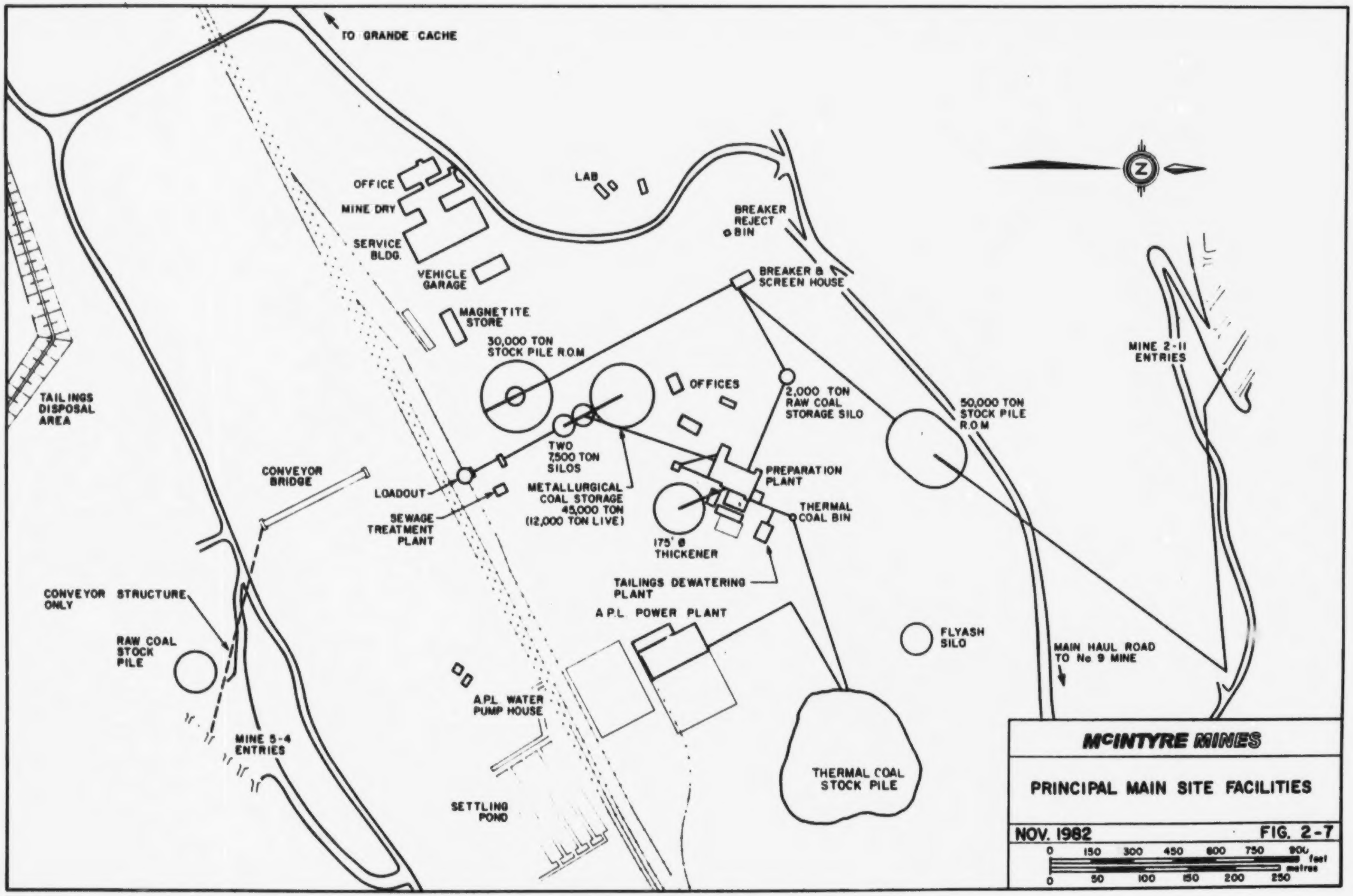
FIG. 2-6

Scale: N.T.S.



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PRINCIPAL MAIN SITE FACILITIES

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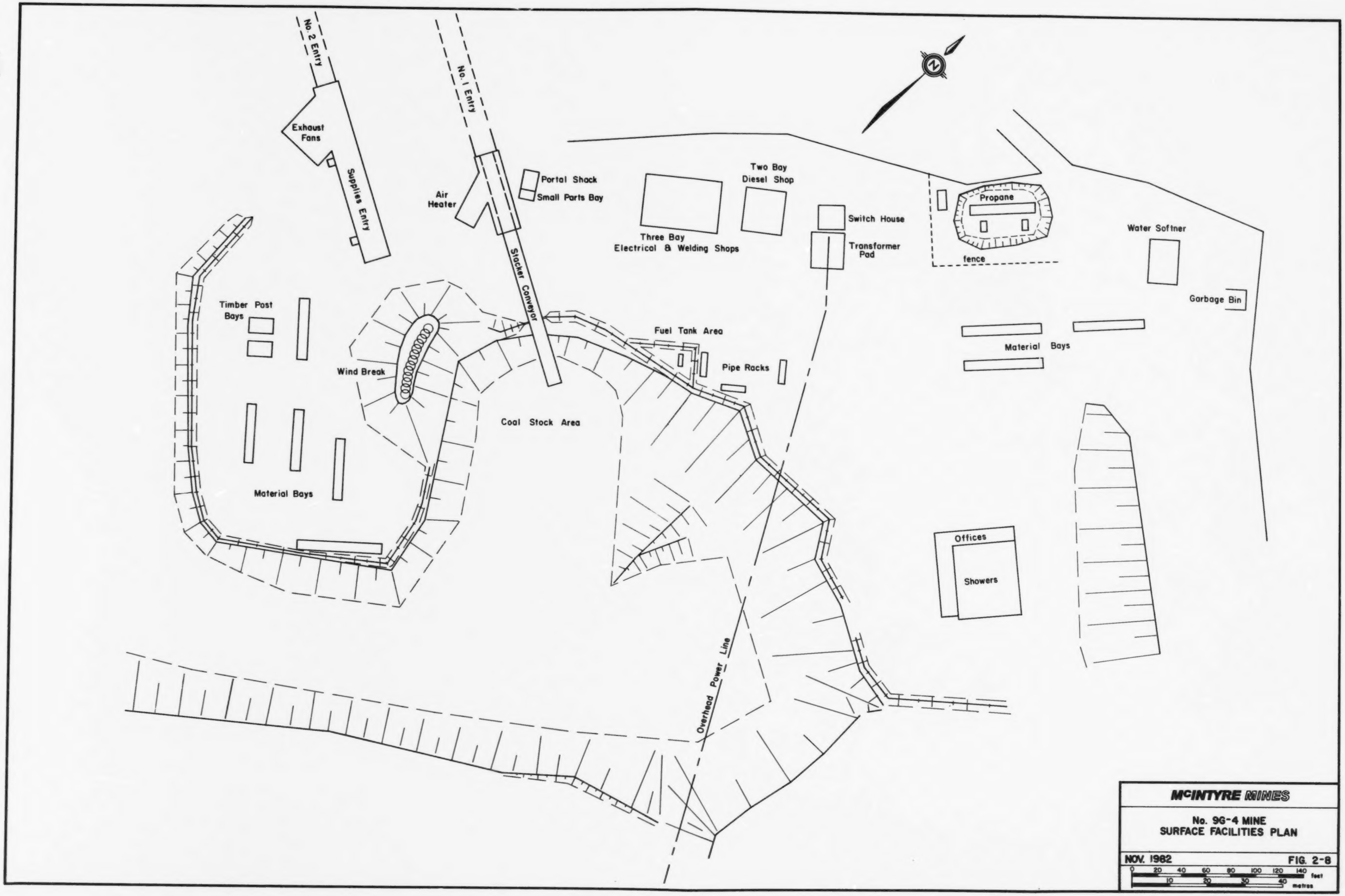
FIG. 2-7

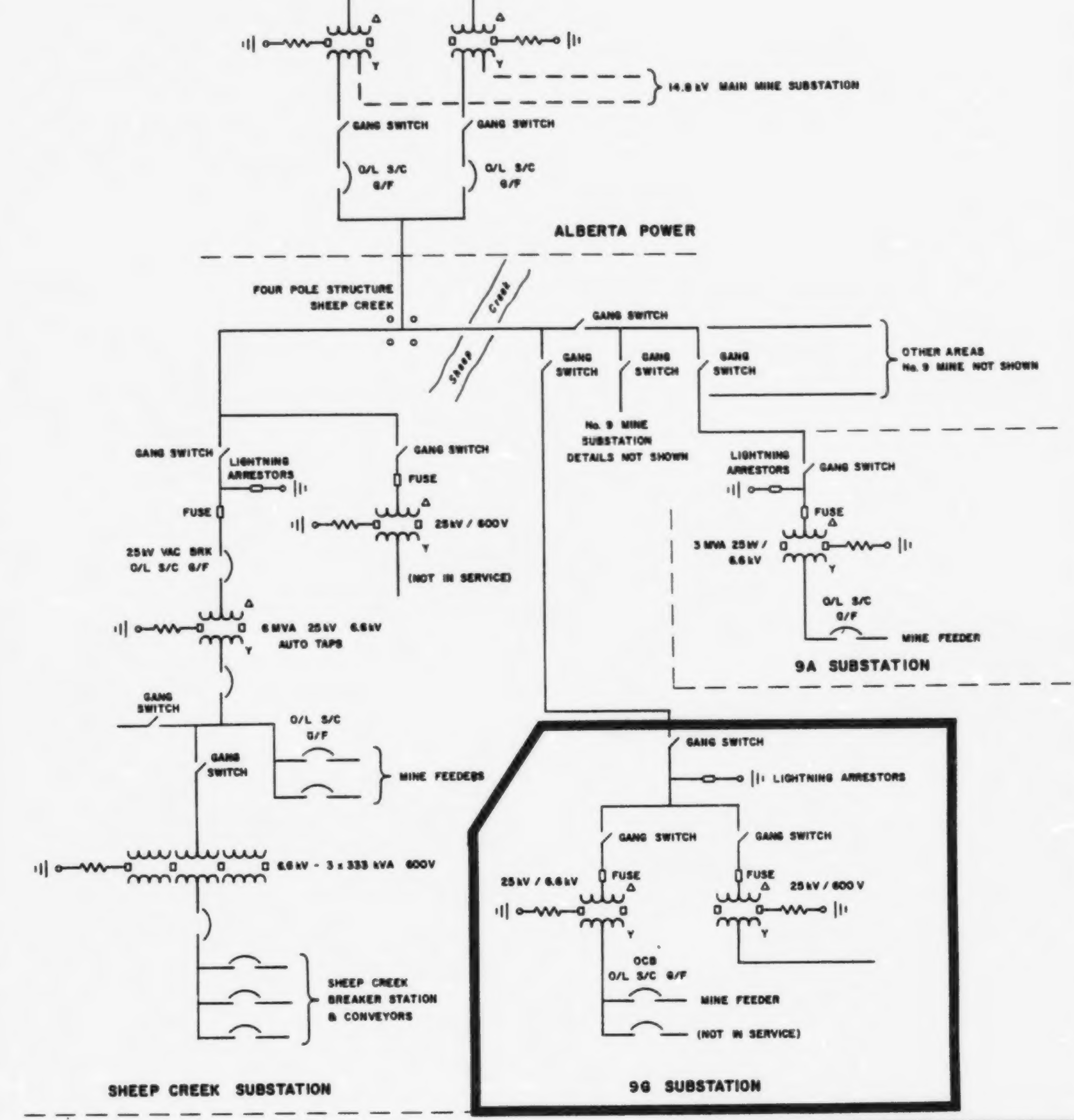


McINTYRE MINES

No. 9G-4 MINE
SURFACE FACILITIES PLAN

NOV. 1982

FIG. 2-8



ALL OVERHEAD LINE IS 266 MCM ASCR (PARTRIDGE STYLE)
AND DRESSED FOR 25kV

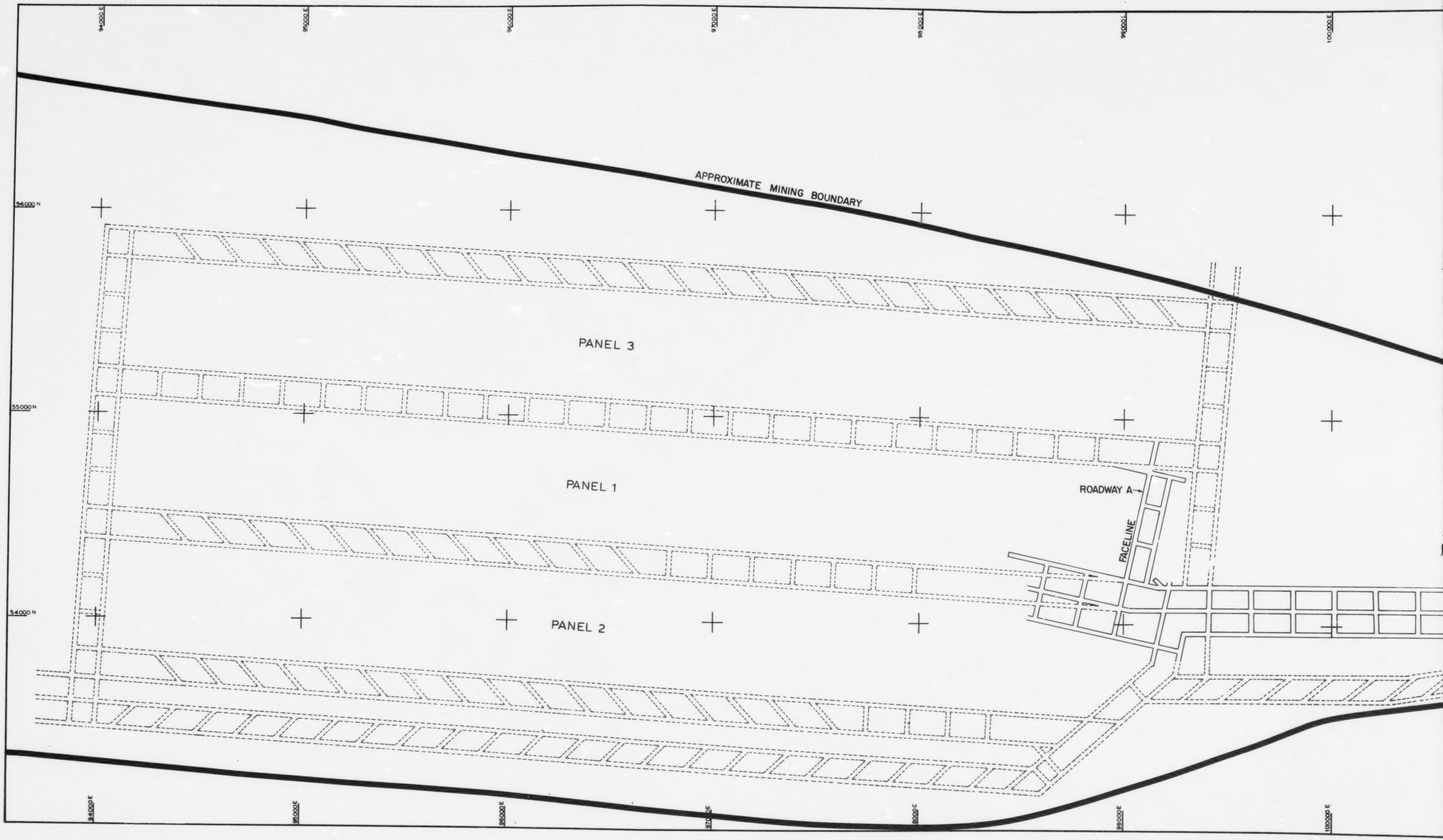
R.L. CLAXTON
16 SEPT. 1982 N.B. NOT FOR CONSTRUCTION

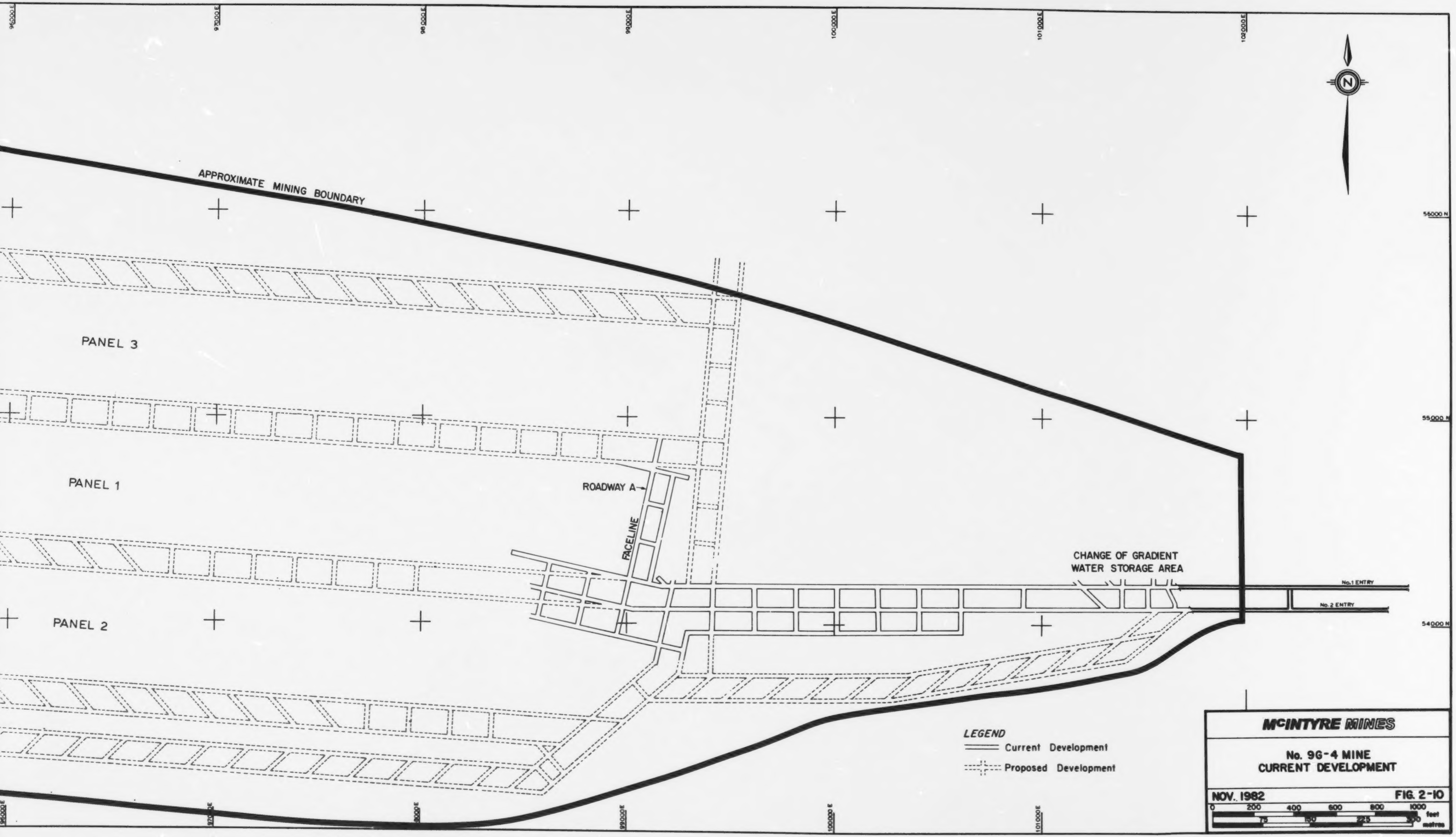
McINTYRE MINES

SINGLE LINE 25kV SYSTEM

NOV. 1982 FIG. 2-9

Scale: N.T.S.


94000 E
95000 E
96000 E
97000 E
98000 E
99000 E
100000 E
56000 N
55000 N
54000 N
APPROXIMATE MINING BOUNDARY
PANEL 3
PANEL 1
ROADWAY A
FACELINE
PANEL 2



LEGEND
- Current Development
- Proposed Development

McINTYRE MINES

No. 9G-4 MINE
CURRENT DEVELOPMENT

NOV. 1982

FIG. 2-10

McINTYRE MINES LIMITED

LONGWALL DEMONSTRATION
PHASE 1

SECTION 3 DESIGN CONSIDERATIONS

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- 3.2.2 Mine Layout
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- 3.2.4 Development
- 3.2.5 Ventilation
- 3.2.6 Transporation
- 3.2.7 Power Supply
- 3.2.8 Communication and Data Transmission
- 3.2.9 Pumping
- 3.2.10 Firefighting and Dust Suppression
- 3.2.11 First Aid and Mine Rescue

TABLES
(Following Text)

Table 3-1 Factors Affecting Development Performance

3.0 DESIGN CONSIDERATIONS

3.1 INTRODUCTION

Section 3 addresses the general principles of planning and design for longwall operations. Parameters have been derived which have been used subsequently to develop detailed mine design and operating sequences.

3.2 PLANNING FOR LONGWALL

The planning of an underground mining operation is a complex process involving detailed consideration of many inter-related variables. For example the factors affecting development performance and their possible inter-relationship are shown in Table 3-1. Consequently, it is often necessary to arrive at a compromise solution based upon an iterative process in which previous experience of mining activity plays a vital role.

Before arriving at a layout and extraction sequence for any longwall mine, the considerations described below must be addressed:

3.2.1 Reserves

Only those areas of the coal reserve defined as proven should be considered for exploitation.

3.2.2 Mine Layout

The design of the mine layout and extraction sequence must maximize reserve recovery and productivity, maintain continuity of output and minimize the effects of extraction on any adjacent mineable coal seams.

3.2.3 Mining Configuration

Longwall operations can be conducted in one of three configurations:

- Longwall retreat.
- Longwall advance.
- Longwall advance/retreat.

The selection of the mining configuration can significantly affect development and roadway maintenance requirements, the level of risk, anticipated production levels and cash flow for the project life. The configuration providing minimum risk and costs should be adopted.

3.2.4 Development

The development system must be such that sufficient development work can be completed to allow the operation of the initial face and thereafter maintain a development rate sufficient to ensure that replacement faces are available as required. The system should be capable of producing coal at an economic rate.

Development roadways should be of an appropriate cross-section to allow for good standards of ventilation with due regard to men and material transport.

In-seam development is desirable in order to reduce to a minimum the amount of roof and floor which must be worked.

3.2.5 Ventilation

The ventilation system should be flexible and able to accommodate changes in ventilation requirements that may occur both seasonally and during the life of the mine.

All working places must be provided with sufficient clean air to reduce any concentrations of noxious or flammable gasses and airborne dust to acceptable standards. Longwall systems can induce significant methane emissions. This should be considered during detailed mine design and must be monitored during operations.

3.2.6 Transportation

Transportation systems must provide for men, material and coal transportation. Rapid safe transportation of the workforce to and from the working place can make a significant contribution to overall productivity by reducing travelling time and increasing available working time. Every effort should be made to provide systems with a minimum number of workers deployed on transportation activities.

Materials transportation systems must be capable of efficient transportation of all supply materials, including large items of equipment, between the mine surface and locations underground.

Coal transportation systems must be capable of transporting coal at peak mining rate unless a bunkering system is employed to level-out production peaks. Unless adequate capacity is provided unscheduled production losses may occur and coal may be spilled from conveyor systems.

3.2.7 Power Supply

The power supply must be of sufficient capacity to allow for ready operation of all equipment. Care must be taken to ensure problems of voltage regulation are minimized. Where necessary, flameproof or intrinsically safe equipment must be employed.

3.2.8 Communication and Data Transmission

An efficient communication system must be established to ensure the safety of personnel and as an aid to production. As a minimum the system should allow ready two-way communication between working areas, coal transfer points and mine surface. Data transmission systems can be installed as required either as distinct and separate facilities or as an integral part of the communication system.

3.2.9 Pumping

If any ingress of water is expected an efficient pumping system should be installed. The pumping system should be designed to function automatically where practicable. The efficient control of unwanted water must be achieved to assure worker comfort and maintain designed production levels.

3.2.10 Firefighting and Dust Suppression

To minimize potential fire hazard and to allow early action in the event of underground fire a permanent firefighting system must be installed. Guidelines for the installation and maintenance of fire fighting arrangements are published by the Energy Resources Conservation Board and must be complied with as a minimum requirement (Appendix 2-3).

3.2.11 First Aid and Mine Rescue

First Aid facilities must be provided both on the surface and underground. A mine rescue service must be available.

TABLE 3-1

FACTORS AFFECTING DEVELOPMENT PERFORMANCE

ITEMS AFFECTING RATE

- SEAM CONDITIONS
- FLOOR CONDITIONS
- ROOF CONDITIONS
- DEPTH OF WORKING
- EXTRACTED AREA
- DRIVAGE CONFIGURATION
- WATER
- EQUIPMENT AVAILABILITY
- EQUIPMENT SELECTION
- LENGTH OF DRIVAGE
- TRANSPORTATION SUPPLIES
- TRANSPORTATION COAL
- METHANE
- VENTILATION
- SHIFTS WORKED PER DAY
- TIME AVAILABLE PER SHIFT
- MANPOWER LEVELS

AFFECT OF VARYING RATE

- PRODUCTION
- AVAILABILITY OF REPLACEMENT FACE
- POWER CONSUMPTION
- WATER CONSUMPTION
- VENTILATION EQUIPMENT SIZING
- SUPPLIES CONSUMPTION
- SIZE OF SUPPLIES EQUIPMENT FLEET
- MOVE UP OF EQUIPMENT
- SUPPORT MANPOWER LEVELS

McINTYRE MINES LIMITED

LONGWALL DEMONSTRATION
PHASE 1

SECTION 4 RESERVE EVALUATION AND DERIVATION OF DESIGN PARAMETERS

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4.0 RESERVES AND DESIGN PARAMETERS

4.1 INTRODUCTION

In Section 4 the general design considerations discussed in Section 3 are applied to the specific conditions in No. 9G-4 Mine to develop appropriate design parameters for detailed mine planning and systems engineering.

4.2 ASSUMPTIONS

The specific design parameters for No. 9G-4 Mine are based on the following assumptions:

- The total area of Seam #4 mineable reserves in the No. 9G Mine would be dedicated to recovery by longwall mining.
- Further development of the No. 9G Mine would not commence until a decision whether or not to proceed with the longwall project is taken.
- If longwall were adopted only development directly related to longwall would be undertaken.
- Sufficient manpower for development and longwall working would be available.
- The cost to access additional reserves would be a charge to the recovery of those reserves.
- Wherever possible, production levels, manpower and detailed costs would be based upon existing operating experience.

4.3 GEOLOGY AND RESERVES

4.3.1 Data Collection

In the total No. 9G-4 Mine area of approximately 0.92 square miles, 66 exploration holes have been drilled, a density of approximately 72 holes per square mile (Table 4-1).

Exploration conducted in 1969 and 1970 was concentrated along the axis and north limb of the Drill Camp Anticline. Holes were drilled using diamond bits to effect core recovery, no geophysical logs were run.

In 1976 and 1977 the north limb of the Drill Camp Anticline and the axis and limb of the Taylor Syncline were extensively explored by rotary drilling with seam core recovery along the north limb of the Drill Camp Anticline. These drillholes were geophysically logged for coal seam location.

Further drilling in 1980 and 1981 provided additional data to improve the geological model already developed. Underground drivages in the No. 9G-4 Mine confirmed the validity of the model in those areas worked. Geophysical surveys in the drillholes include gamma ray-neutron, density, caliper, focused beam and dip meter.

During the 1981 program seven of the drillholes were equipped with piezometer tubes. Three of these installations are still operating.

A catalogue of geological information was established for Seams #4, #10 and #11 in which seam co-ordinates, roof and floor elevations and seam thicknesses were defined. Where possible, geophysical logs were used to determine roof and floor intercepts. Geophysical directional surveys in conjunction with surface surveys were used to determine the location of each seam intercept. Directional survey data was not available for the 1969 and 1970 diamond drillholes which were assumed to be vertical and the data interpreted accordingly.

From this data base plans and sections were developed at a 1:200 scale. The cross-sections were constructed at 250 ft intervals (Appendix 2-9).

Plans

-	Seam #4 Cover Isopach (Vertical Thickness)	Plan 1
-	Seam #10 Cover Isopach (Vertical Thickness)	Plan 2
-	Seam #4 - Seam #10 Interburden Isopach (Vertical Thickness)	Plan 3
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Cross-sections

-	Cross-sections along AA, BB and CC	Plan 8

Drillhole Sections

-	Drillhole Sections	9G-4 Seam	Plan 9
	Drillhole Sections	9-10 Seam	Plan 10

As variation in stratigraphy is minimal, data was interpolated equally between drillholes in the preparation of isopach maps.

The structure contour maps take account of the gradual change in strike of the strata adjacent to the axis of the syncline and anticline structures.

4.3.2 Interpretation

The mine boundaries are largely determined by geologic features. The southern edge of the mine is bounded by the Drill Camp Anticline which plunges to the east, the northern edge of the mine is bounded by the Taylor Syncline which plunges to the west and on the northwest corner of the mine the strata upturns to the Barrett Anticline.

Between the Drill Camp Anticline and the Taylor Syncline the structure dips to the north at between 10° and 30° and is gently rolling. At the extreme northwest of the area data from a single drillhole suggests that the strata dips at 35° to 40° in a monocline fold. Generally, the structural style in the mine area is best depicted by the Seam #4 structure contour map (Figure 4-1).

In the area to be mined Seam #4 is 20 to 25 ft thick and contains a 1.5 ft thick high-ash parting approximately 4 to 5 ft above the floor of the seam. The coal above this parting has a slightly lower ash content than the coal below. The typical lithology of Seam #4 is shown on Plan 9 (Appendix 2-9).

The floor of the seam is an interbedded siltstone and mudstone with sandstone lenses. Immediately above the seam is a thin layer of interbedded carbonaceous shale, dirty coal and coal approximately 0.5 to 1 ft thick. This is overlain by an average of 15 to 20 ft of interbedded siltstone and fine grained sandstone which grades into a massive sandstone.

Seam #10 lies some 250 ft above Seam #4 and varies in thickness from 8 to 12 ft. The upper section of Seam #10 consists of coal, shale, dirty coal and bone coal and has a higher ash content than the lower section which closely approaches the quality of Seam #4.

The floor of Seam #10 is a mudstone or siltstone. The immediate roof strata comprises approximately 15 ft of mudstone and siltstone which contains two carbonaceous coal splits 1 to 2 ft thick.

An independent evaluation of the data base and its interpretation was conducted by Norwest Resource Consultants (Appendix 3-1), which confirmed McIntyre's findings.

4.3.3 Reserve Calculations

Proven reserves in the No. 9G-4 Mine area are based on reserve parameters which extrapolate drillhole data 500 ft along-dip and 1000 ft along-strike from a known seam intercept. The vertical seam thickness isopach plan for each seam was used to determine in place volumes. A specific gravity of 1.35 for Seam #4 was used to convert calculated volumes to tonnage.

The reserves tonnages were further classified to show reserves at 0° to 15°, 15° to 20° and greater than 20°. Table 4-2 provides a summary of the reserves by category.

Based on evaluations by McIntyre and reviewed by its consultants, it is concluded that there are some 15.4 million tons of proven reserves in the area being considered for mining.

4.4 GEOTECHNICS

4.4.1 Introduction

The behaviour of the strata adjacent to a longwall both during development, mining and after mining, can have a significant effect on the safety and productivity of operations.

For successful longwall mining the roof must cave in a controlled manner into the void created by coal extraction. Roof supports must develop sufficient resistance to induce the immediate roof strata behind the supports to break and fall. After caving the caved material should offer support to the upper strata, which can then move downward as an unbroken beam in the mined-out area behind the longwall.

4.4.2 Strata Control Observations

Room and pillar mining is currently being conducted in No. 9A-4 Mine close to the No. 9G-4 Mine. A depillaring section (1 West) has been retreating along a 500 ft front, providing a realistic indication of the conditions likely to be encountered in longwall operations in No. 9G-4 Mine (Figure 4-2).

Over three months of operation, daily observations of waste caving, roadway closure, pressure on pillars and stress measurements were made in No. 9A-4 Mine (Appendix 4-1, Part 3 Geotechnical Data). These observations show that while, as would be expected, the line of caving created by room and pillar working is uneven, with remnant coal pillars in some locations, caving occurred in a controlled and satisfactory manner. The first waste fall was usually 4 to 6 ft behind supports left to induce roof break. This fall of some 8 to 10 ft above the seam was at an angle of about 40° to the vertical. Subsequently the roof breaks again to a higher level and completely fills the void. The waste caves fairly readily and roof control is good.

While pressure measurements taken from transducers mounted on wooden props did not provide sufficient data for a complete analysis, they clearly indicated that pressure increases were at the locations expected. The progressive development of breaks and the limited outward movement of the coal in pillars showed that the load was being safely taken by the pillars. Very little measureable roadway closure occurred, even in those areas adjacent to the ribside pillars.

Based upon these observations, the following projections have been made related to roof control with a longwall operating in No. 9G-4 Mine:

- Since caving was satisfactory in No. 9A-4 Mine despite an irregular break-off line caving would be further improved with the longwall system.
- Caving will relieve forward abutment pressure, and strata problems occasioned by roof break or floor heave are not anticipated.
- The waste will cave in a satisfactory and systematic manner.
- If a straight caving line, as provided by a longwall system, can be established and total extraction achieved, caving would be further enhanced.
- Caving will take place in two phases with initial caving taking place up to 8 to 10 ft above the seam and later caving to higher levels to completely fill the void.
- During initial caving the edge of the immediate caved roof will be at an angle of 30° to 40° to the vertical.

Confirmatory geotechnical data has been derived from studies conducted by:

- Norwest Resource Consultants: An Appraisal of the Roof Strata of the No. 4 Seam in the Area Planned for Longwall Development (Appendix 3-2).

- Coal Mining Research Centre: Preliminary Plate Load Tests at McIntyre Mines (Appendix 4-1 Floor Strength).
- Seegmiller International: Geotechnical Evaluation Logging/Testing/Analysis No. 9G-4 Mine (Appendix 3-3).
- R.M. Hardy Associates: Report on Geotechnical and Hydrological Factors Relative to Proposed No. 9 Mine Extension (Appendix 4-1 Geotechnical Data).

4.4.3 Support Requirements

One well established approach to determining roof support capacity is to consider the mass of rock which must be supported and held in position by the supports. For calculation purposes it is assumed that the immediate roof strata caves and the upper roof strata, while it may develop fractures, remains continuous and gradually lowers, compressing the caved waste material below it. Figure 4-3 shows the caving process on a typical longwall face.

The horizontal stresses originally present in the strata help maintain the integrity of the upper roof and any joints or breaks are closed by the compression forces. This effect is augmented over the working area by the curvature of the strata which aids compression of the lower surface of the upper roof.

The immediate roof strata is not continuous and has a free-face along the caving line. The horizontal compressive forces will be absent and it must rely for stability on the supports. Should the supports be removed the immediate roof strata will collapse and the caving line will move forward to the face but the upper roof will remain intact. Accordingly, it is only the immediate roof strata which need be considered when calculating the required support capacity.

If the roof remains unbroken over the working area the supports will not be required to carry the full weight of the immediate roof strata since it will possess some inherent stability as a cantilever projecting outward from and supported at the face. Additional support may be created as a result of adhesion between the upper and lower beds of the strata.

Should a break-line occur at the face combined with a loss of adhesion between the immediate and upper strata, the full weight of the strata will be thrown onto the supports. While this is not a common occurrence the possibility does exist and it is this extreme condition which has been adopted for assessing the support capacity required to maintain the stability of the immediate roof strata.

Based on observations at No. 9A-4 Mine calculation has determined that the minimum support capacity required for No. 9G-4 Mine is 450 tons (Appendix 2-5).

In order to provide a safety factor, 600 ton capacity supports will be specified. Standard 600 ton supports exert a floor pressure of about 320 psi and a roof pressure of about 180 psi at yield. Figure 4-4 shows a typical arrangement for roof support.

To ensure satisfactory roof control by the longwall support system the roof and floor of the extracted section must be competent to withstand the compressive forces applied at yield condition. Each type of support will exert a different compressive force at yield which will depend upon the surface area of the base or roof beam and the yield pressure.

It should be noted that in two-dimensional analysis the length of roof strata to be supported, the vertical line of application of this weight and the vertical line of support reaction may vary depending upon the support design and type.

Tests and observations confirm that the immediate roof and floor strata in No. 9G-4 Mine are able to withstand the forces to be applied.

4.4.4 Conclusions

The reserves in the No. 9G-4 Mine are geotechnically amenable to extraction by longwall mining, provided the longwall support system is appropriately engineered.

4.5 LONGWALL GEOMETRY

4.5.1 Introduction

In most cases it is not possible to achieve an optimum value for every variable in longwall operations and a compromise solution must be sought. For example, to achieve total coal recovery, the full seam section should be extracted and no coal should be left in pillars. This is not technically feasible in Seam #4 so a compromise must be adopted which will maximize recovery within the limitations of available equipment and mining techniques.

4.5.2 Extraction Section

Seam #4 varies from 20 to 25 ft in thickness over the proposed mine area. The seam contains a section of up to 5 ft of soft coal located approximately 12 to 14 ft below the top of the seam. The location of the soft coal band in the seam is reasonably constant throughout the area to be mined (Appendix 3-5). The coal in this zone is of slightly lower quality than the remainder of the seam, but both above and below this soft coal zone the coal is of good quality.

The roof of the seam is a coal/shale mixture locally known as "caprock" which is generally less than 1 ft thick in the area to be mined. This caprock is overlain by banded shales and siltstones with interbedded sandstones. The base of the seam is a very hard siltstone.

Tests conducted by CMRC to determine the strength of various coal horizons in the seam show that the bearing strength of the soft coal zone near the middle of the seam is low and that difficulties would be encountered if roof supports were required to operate on a floor of this material. However the bearing strengths of the coal sections above and below this zone are capable of supporting the loads that may be imposed by modern roof support systems at yield condition. Figure 4-5 shows the thickness of hard coal above the sheared coal zone for a 10 ft extraction height.

Current longwall technology is successfully being applied in many locations to extract thick seams about 10 to 12 ft in height. Equipment capable of extracting even thicker sections is in limited use. An extraction height of 10 ft would allow well proven mining techniques and equipment to be employed, thus maximizing the potential for success.

Equipment capable of mining a 10 ft section could be employed in one of three ways:

- The equipment can be installed on the floor of the seam and mine to a competent coal roof. This system would pose several significant problems:
    - since the soft coal zone is not capable of providing a competent roof it must be totally extracted
    - the equipment would be required to accommodate any variation in floor geometry or the position and thickness of the soft coal zone
    - development drivages must either be undertaken totally in the coal seam with a coal roof or the total seam must be extracted
    - since the quality of the coal in the soft coal zone is slightly inferior to the remainder of the seam clean coal yield would be reduced
- A section of the seam can be extracted with supports based on the lower section of competent coal and the equipment used to mine to a competent coal roof. This system would pose problems similar in nature to those encountered when operating from the floor of the seam. Additional difficulty in maintaining suitable roof and floor horizons and attendant operational problems would also be encountered.
- The equipment can be installed to mine to the roof of the seam with the supports based on a competent coal floor. This system would allow roadway development in the top 10 ft of the seam using established techniques for roadway drivage and roof support. Additionally, since the soft coal zone appears approximately 14 ft below the roof, a 10 to 12 ft section of the seam can be extracted while retaining 2 to 4 ft of competent coal above the soft coal zone as a strong base for the support system. Horizon control problems would be minimized and clean coal yield would be maximized.

Based on the foregoing, the recommended extraction section is 10 ft, with the supports based upon a strong coal floor and operating to the roof of the seam.

4.5.3 Face Length

Many longwall faces are installed and operating at lengths from 150 to 900 ft with the majority of faces operating in the range of 450 to 600 ft.

The area of reserve to be exploited in No. 9G-4 Mine is approximately rectangular, over 5000 ft long by 2400 ft wide. As such, a mining plan could be developed to accommodate a wide range of face lengths.

Successful longwall operations depend to a large extent on the ability to achieve adequate control of the strata adjacent to the longwall operation. Generally two basic concepts for strata control are adopted which influence the selection of face length.

In the first case the face length is chosen to ensure that the overlying strata will not cave into the waste but will bridge across supporting pillars adjacent to the face. This method requires relatively short faces and large unyielding pillars and consequently reduces reserve recovery. This technique is used in special cases, usually where there is significant concern about surface subsidence or where massive sandstone is encountered.

In the second case the face length is chosen to ensure that the void created by coal extraction will eventually be filled by the controlled caving action of the waste behind the coal face supports. This maximizes reserve recovery and is the method usually employed.

Generally, longer faces provide improved productivity, since the ratio of face cutting time to operation delay time is improved. Reserve recovery is also improved since the ratio of face extraction volume to support pillar volume increases. However, constraints on face length can be imposed by considerations of capital cost, mechanical capability and operational control.

To ensure total caving of the waste at No. 9G-4 Mine the depth of cover up to 12 000 ft, requires that face lengths be in excess of 400 ft (CMRC Study Appendix 3-4).

A 550 ft face operating length has been selected in order to:

- Maximize reserve recovery within the mine boundary.
- Ensure that longwall equipment is employed well within its design limits.
- Maintain potential for extraction of Seam #10 with longwall of viable length.

4.5.4 Roadway and Face Alignment

In some areas, the presence of residual stress and tectonically induced strata fractures can have a significant effect on development and longwall mining activities.

Residual Stresses

Mining experience indicates that lateral and horizontal stresses which develop during mining activity tend to be directional. This has been demonstrated in many instances when roadways developed at right angles to each other exhibit distinctly different convergence and stress characteristics.

Previous experience in the No. 9 Mine area, which involved the development of roadways in many different directions, shows only limited effects which can be attributed to residual strata stresses. From observations in No. 9A-4 Mine it does not appear that inherent stresses would be a major problem. Roadways within the No. 9G-4 Mine are standing well with little or no roadway convergence.

Strata Fractures

The major fracture patterns associated with previous tectonic activity occur along a northwest-southeast line (Figure 4-6). Minor breaks occur at right angles to the direction of the major break-lines.

The break pattern within the coal and strata may cause problems, unless roadway and face alignment are correctly chosen. To minimize the risk of problems, a face alignment which is not parallel to either line of break is recommended.

Panel Alignment

The area of coal to be exploited in No. 9G-4 Mine is roughly rectangular. To maximize reserve recovery the most appropriate direction of development and extraction is either development along-strike with the face-line on dip or development to-the-dip with the face-line along-strike.

Alignment in either direction would ensure that extraction would be at an angle of some 20° to the tectonically induced line of fracture. Since residual stresses do not appear to cause undue difficulties either alignment could be applied.

4.5.5 Roadway Configuration

The longwall is planned to extract the top 10 ft (Section 4.5.2) of the seam and it is recommended that the development roadways be driven in this same section.

To minimize ventilation pressure drop along the roadway system, air velocity should not exceed 500 fpm in the main intake airway. The volume of air required for longwall operations is estimated to be up to 60 000 cfm and the roadway cross-section should therefore be a minimum of 600 000 ÷ 500 = 120 sq ft.

The floor of the roadway must be relatively horizontal across the roadway and the roof beds above the seam should not be disturbed during development, to facilitate effective support by roof bolting.

Development roadways are currently driven at Smoky River with a rectangular configuration generally 20 ft wide by 10 ft high, in seams inclined at up to 18° to the horizontal. The roof is supported by roof bolts and the sides by wooden posts and bars.

The equipment and techniques currently in use can drive roadways at grades of up to 18°. Above this grade boom type equipment will be employed to minimize disturbance to the adjacent roof strata.

4.6 DEVELOPMENT CONFIGURATION

Mining layouts for longwall can be developed using single or multiple entry systems. In general single entry configurations provide maximum reserve recovery while multiple entry systems reduce recovery unless pillars can be recovered.

With the longwall system it is essential to ensure that a replacement face is ready to accept the longwall equipment as soon as it is released from the completed operating face. The rate of development required and maintenance of roadways are important considerations.

4.6.1 Single Entry

Development of No. 9G-4 Mine using a single entry configuration would require roadway drivage techniques not presently employed at Smoky River.

Long single entry roadways would have to be driven and problems of equipment movement, equipment installation and ventilation resolved.

To maximize the benefit to be gained from single entry development the roadway would have to be maintained and re-used for succeeding longwall panels. Although feasible this would require significant roadway maintenance activity and mining techniques new to Western Canada.

4.6.2 Multiple Entry System

There has been extensive experience at Smoky River of developing long drivages using two and three entry systems, with coal pillars between roadways for support.

The design of a multiple entry system is complex. Pillar size must suit the mining system and pillars may be non-yielding, yielding or failing in character to control stress development.

To achieve strata control in the entries and minimize the effect of side abutment pressures when the longwall face is being retreated, a three or five entry system can offer advantages. However such a design requires two or more pillars between faces which reduces reserve recovery.

The two entry system leaves a single pillar between adjacent longwall faces. This pillar will take the side abutment pressures due to the initial development drivage while later it will be subjected to front abutment pressures from two faces. The pillar must therefore be suitably designed not to yield during development or working of the first face, after which it should then yield in a controlled manner after the second face has worked by.

For the first panel roadways could be developed using existing equipment and mining systems, with the minimum number of cross-cuts and adequate pillars to afford roadway support. Each roadway will function as a part of the longwall face retreat system in the extraction sequence.

As the demonstration progresses, it may be necessary to employ different equipment for the development of roadways in more steeply inclined areas.

The advantage to be gained from the use of existing equipment to develop two entry roadways include:

- Reduced capital expenditure.
- Reasonable rates of advance and productivity.

- Availability of trained and experienced supervisory and operating personnel.
- Ease of supply and equipment installation both during development and for longwall operations.
- Use of proven ventilation systems for the development activity.
- Provision of a second means of egress for mine operatives employed on the development activity.

4.6.3 Recommended System

To maximize reserves recovery the minimum number of development roadways should be driven, ideally one. However, to utilize the single entry system a technique new to Western Canada would need to be employed and a number of mining problems would require resolution.

Such problems will be minimal with a two entry configuration, since the equipment and operating expertise are readily available. The two entry system is therefore recommended.

Typical equipment specifications for development operations are shown in Appendix 2-8.

4.7 MINING CONFIGURATION

Longwall equipment can be deployed and operated in any of three different configurations:

- Advancing
- Retreating
- Advance/retreat

All three configurations are successfully employed elsewhere and any one could be applied at Smoky River.

The adoption of a particular configuration determines the mine layout and development/roadway maintenance requirements. Selection of the most appropriate configuration can simplify operations and provide the best environmental conditions.

4.7.1 Advancing

In longwall advance the equipment is installed and advances into the reserve area with the gate and supply roadways being developed as the face advances (Figure 4-7). Single roadways supported on steel arches are generally used. Since the roadways developed with the face are the only means of access they must be supported at the caved edge by packs or chocks to assist in maintaining the roadway. This can restrict the rate of face advance.

4.7.2 Retreating

In longwall retreat the equipment is installed between two pre-driven roadways which extend for the total length of the panel to be extracted (Figure 4-8). Faces are retreated from the extreme end of the developed roadways which are allowed to collapse following coal extraction. Support density in these roadways is usually less than for single entry systems. Since the area to be mined has been circumscribed by developed roadways a sound knowledge of geology and mining conditions is available before mining.

4.7.3 Advance/Retreat

In longwall advance/retreat the equipment is installed between two pre-driven roadways which extend for some distance ahead of the face-line and continue to be developed as the face advances (Figure 4-9). Limited information on geology and mining conditions ahead of the face is available from development but the operation is complex and requires co-ordination of all activities to ensure proper operation.

Table 4-3 summarizes the advantages and disadvantages of each configuration as they apply to the No. 9G Mine.

4.7.4 Recommended Configuration

The outcome of the demonstration longwall project will have a significant impact on the propagation of longwall mining in Western Canada and the method selected should offer the minimum risk. Although it requires significant pre-production expenditure on development drivages, longwall retreat using twin entries is recommended as the lowest risk approach.

4.8 SUMMARY

The following parameters have been derived and adopted for the detailed design of the longwall:

- Exploitation of 15.4 million tons of reserves in Seam #4.
- A retreating longwall configuration will be used.
- A two-entry development method will be employed using existing equipment.
- A total caving system will be adopted using 600 ton supports.

- A 10 ft section will be extracted with the supports based on a competent coal floor, contacting the roof of the seam.
- The face length will be approximately 550 ft.
- The alignment of development roadways and longwall faces will be at approximatly 20° to the direction of tectonically induced fractures.

TABLE 4-1

DRILL HOLE SUMMARY IN NO. 9G MINE AREA

	HOLE NO.	4 SEAM	10 SEAM	11 SEAM	DIAMOND DRILL	ROTARY	ROTARY SEAMCORE	GAMA RAY NEUTRON	DENSITY	CALIPER	FOCUSED BEAM	DIRECTIONAL SURVEY
1981	81 - 11	x	x	x		x		x	x	x	x	x
	81 - 12	x	x	x		x		x	x	x	x	x
	81 - 13	x	x	x		x		x	x	x	x	x
	81 - 14	x	x	x		x		x	x	x	x	x
	81 - 15	x	x	x		x		x	x	x	x	x
	81 - 16	x	x	x		x		x	x	x	x	x
	81 - 17	x	x	x		x		x	x	x	x	x
	81 - 18	x	x	x		x		x	x	x	x	x
	81 - 19	x	x	x		x		x	x	x	x	x
	81 - 22	x	x	x	x			x	x	x	x	x
	81 - 23	x	x	x	x			x	x	x	x	x
	81 - 24	x	x	x	x			x	x	x	x	x
	81 - 29		x	x	x			x	x		x	
	81 - 31	x	x	x		x		x	x	x	x	x
	81 - 32	x	x	x		x		x	x	x	x	x
	81 - 33	x	x	x		x		x	x	x	x	x
1981	SUB TOTAL	15	16	16	4	12	—	16	16	15	16	15
1980	80 - 01	x	x	x		x		x	x	x		x
	80 - 02	x	x	x		x		x	x	x	x	x
	80 - 03	x	x	x		x		x	x	x		x
	80 - 04	x	x	x		x		x	x	x	x	x
	80 - 05	x	x	x		x		x	x	x	x	x
	80 - 06	x	x	x		x		x	x	x	x	x
	80 - 07	x	x	x		x		x	x	x	x	x
	80 - 08	x	x	x		x		x	x	x	x	x
	80 - 09	x	x	x		x		x	x	x	x	x
	80 - 10	x	x	x		x		x	x	x	x	x
1980	SUB TOTAL	10	10	10	—	10	—	10	10	10	8	10
1977	77 - 63		x	x		x		x	x	x	x	x
	77 - 69	x	x	x		x		x	x	x	x	x
	77 - 70	x	x	x		x		x	x	x	x	x
	77 - 71	x	x	x		x		x	x	x		x
1977	SUB TOTAL	3	4	4	—	4	—	4	4	4	3	4
1976	76 - 114	x	x	x			x	x	x			x
	76 - 115	x	x	x			x	x	x	x	x	x
	76 - 116	x	x	x			x	x	x			x
	76 - 116	x	x	x			x	x	x			x
	76 - 117	x	x				x	x	x			x
	76 - 118	x	x				x	x	x	x	x	x
	76 - 120	x	x				x	x	x			x
	76 - 121	x	x	x			x	x	x			x
	76 - 122	x	x	x			x	x	x			x
	76 - 123	x	x	x			x	x	x		x	x
	76 - 124	x	x	x			x	x	x	x	x	x
	76 - 125	x	x	x			x	x	x			x
	76 - 126	x	x	x			x	x	x			x
	76 - 127	x	x				x					
	76 - 128	x	x	x			x	x	x			x
	76 - 130	x	x	x			x	x	x			x
	76 - 132	x	x	x			x	x	x			x
	76 - 139	x	x	x			x	x	x			x
	76 - 145	x	x	x			x	x	x			x
	76 - 146	x	x				x	x				x
	76 - 147	x	x	x			x	x	x			x
	76 - 150	x	x	x			x	x	x			x
1976	SUB TOTAL	21	21	16	—	—	21	20	19	3	4	20
1970	70 - 25	x	x	x	x							
	70 - 27	x	x	x	x							
	70 - 28	x	x	x	x							
	70 - 32	x	x	x	x							
	70 - 34	x	x	x	x							
	70 - 37	x	x	x	x							
1970	SUB TOTAL	6	6	6	6	—	—	—	—	—	—	—
1969	69 - 19	x	x		x							
	69 - 23	x	x		x							
	69 - 24	x	x		x							
	69 - 26	x	x	x	x							
	69 - 28	x	x	x	x							
	69 - 30	x	x	x	x							
	69 - 31	x	x	x	x							
	69 - 34	x	x	x	x							
	69 - 36	x	x	x	x							
1969	SUB TOTAL	9	9	6	9	—	—	—	—	—	—	—
1969 - 1981	TOTAL 70 - 28	64	66	58	19	26	21	50	49	32	31	49

TABLE 4-2

PROVEN RESERVES - 9G-4 MINE

# 4 SEAM

	RESERVES IN PLACE (LTR)
0 - 15°	6,271,000
15 - 20°	7,310,000
+ 20°	1,823,000
TOTAL	15,404,000

TABLE 4-3
COMPARISON OF LONGWALL MINING CONFIGURATIONS

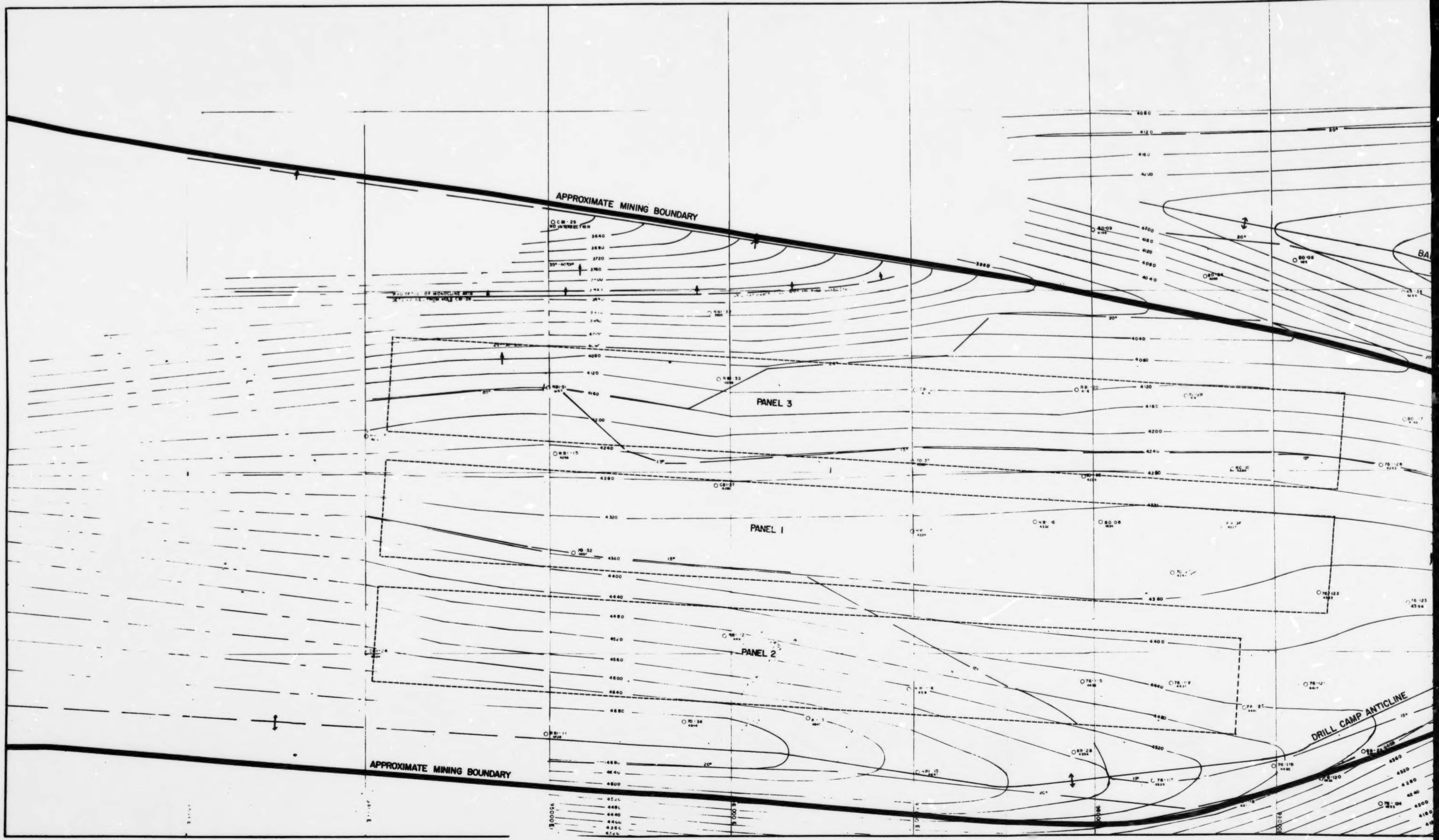
ITEM	ADVANCE LONGWALL	RETREAT LONGWALL	HYBRID LONGWALL RETREAT
1. Mining Related Data	Restricted to borehole data and data obtained from adjacent mining activities.	Maximum amount of data available.	As for advance system, supplemented by limited additional data from advanced roadway development.
2. Roadway Development	Roadways are developed with the face advance. Single steel supported entries are normal.	Roadways are fully developed before face installation. Single or multi entry systems may be used.	Roadways are developed ahead of the face. Single or multi entry systems may be used.
3. Roadway Maintenance	Heavy roadway maintenance requirement usual where thick seams are extracted.	Limited roadway maintenance required. Attention to front abutment zone may be required.	Heavy maintenance requirement for single entry system. Attention to abutment zone may be required for multi entry system.
4. Roadside Packs	Required to provide roadway stability.	Not normally required.	Required if single entry system adopted.
5. Reserve Recovery	Maximized with this system, particularly if roadways can be reused.	Development configuration affects recovery.	Development configuration affects recovery.
6. Face Extraction - Panel Length	Can exceed prescribed length if mining conditions are favourable.	Prescribed.	Can exceed prescribed length if mining conditions are favourable.
7. Mining Support Equipment Conveyors, Pipelines, etc.	Installed as face advances.	Fully installed at commencement of face operations. Withdrawn as face retreats.	Installed as face advances.

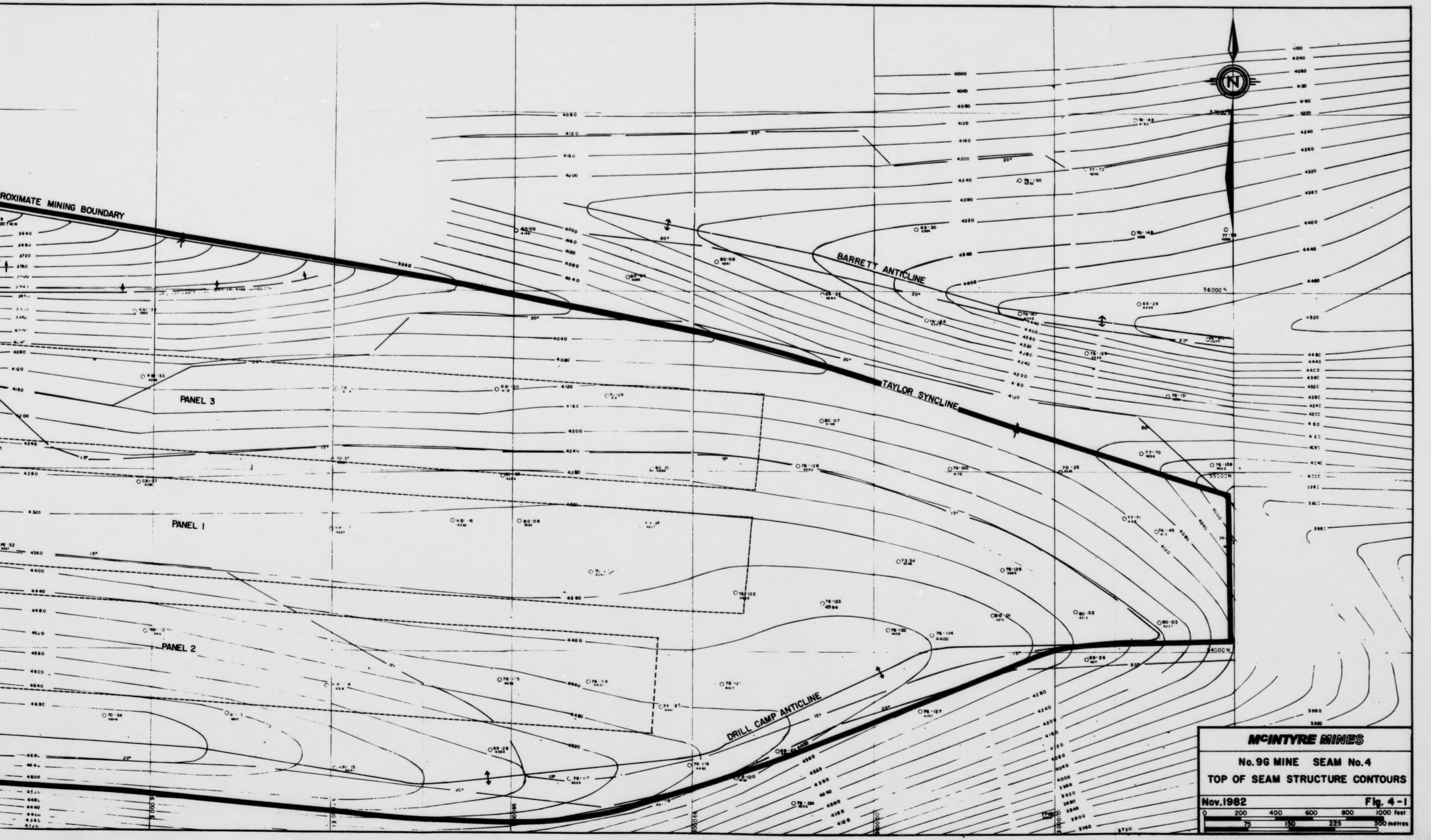
TABLE 4-[illegible] (Cont'd)
COMPARISON OF LONGWALL MINING CONFIGURATIONS

ITEM	ADVANCE LONGWALL	RETREAT LONGWALL	HYBRID LONGWALL RETREAT
8. Development Equipment	Usually specialized or heavily manpower intensive.	No special requirements unless single entry systems envisaged.	No special requirements unless single entry systems are envisaged.
9. Ventilation System	Relatively simple, must accommodate ventilation for headings.	Simple and uncomplicated.	Complex arrangements necessary to ensure proper ventilation of advance headings.
10. Spontaneous Combustion	Can be the source of continuing problems.	Can be more readily controlled - problems left behind as face retreats.	This system is not suitable if spontaneous combustion problems are to be anticipated.
11. Mining System	Special roadhead arrangement necessary to accommodate roadway drivage. Packs required along roadside.	Simple.	Complex activity on both development and longwall must be coordinated. Single entry systems require roadway packs following face extraction.
12. Environmental Control	Difficult at face ends.	Relatively simple.	Difficult at face ends due to advance drivage activity.
13. Equipment Recovery	May be difficult, all face and other equipment must be transported out along roadways which may have converged.	Equipment is recovered as face retreats.	As for advance - additional large items of equipment require transportation.

TABLE (Cont'd)
COMPARISON OF LONGWALL MINING CONFIGURATIONS

ITEM	ADVANCE LONGWALL	RETREAT LONGWALL	HYBRID LONGWALL RETREAT
14. Face and Development Supplies	Must be transported and stored until used in single roadway subject to convergence. Distance increases as face advances.	Relatively simple since transport will be through unstressed roadways and distance decreases as face retreats.	Similar to advance but additional difficulties may arise in transporting materials across the face line.
15. Initial Face Installation	Presents a short route for transport and installation.	May require lengthy transportation and require longer installation time.	Same as for advance.
16. Expenditure Required Before Face Installation	Reduces initial development expenditure to a minimum.	Requires maximum expenditure on development.	Require more than minimum expenditure as initial development expenditure determined by amount of roadway maintained ahead of face advance.
17. Manpower at Face	Development work crew must be included. Construction of roadway packs requires additional manpower and equipment.	Face operations crew only.	Significant number of additional persons employed on development work. Single entry system will require roadway pack erection crew.
18. Mining Risk	Highest, since only minimum of information on expected mining conditions available.	Lowest since maximum amount of mining data available.	High since only limited data data available at outset of mining.


APPROXIMATE MINING BOUNDARY
APPROXIMATE MINING BOUNDARY
PANEL 3
PANEL 1
PANEL 2
DRILL CAMP ANTICLINE
NO INTERSECTION
3640
3680
3720
3760
4000
4040
4080
4120
4160
4200
4240
4280
4320
4360
4400
4440
4480
4520
4560
4600
4640
4680
20°
15°



McINTYRE MINES

No. 9G MINE SEAM No. 4

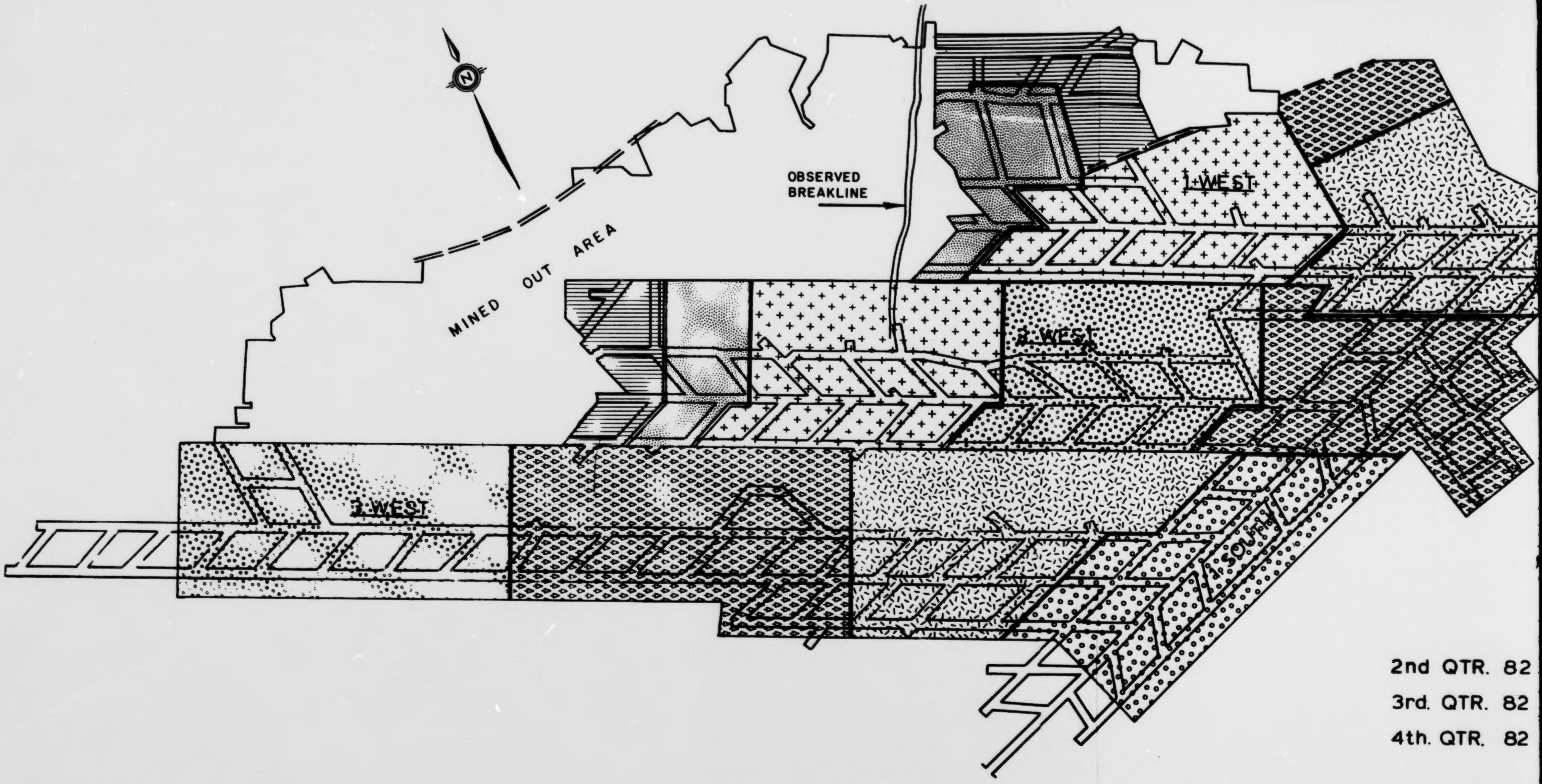
TOP OF SEAM STRUCTURE CONTOURS

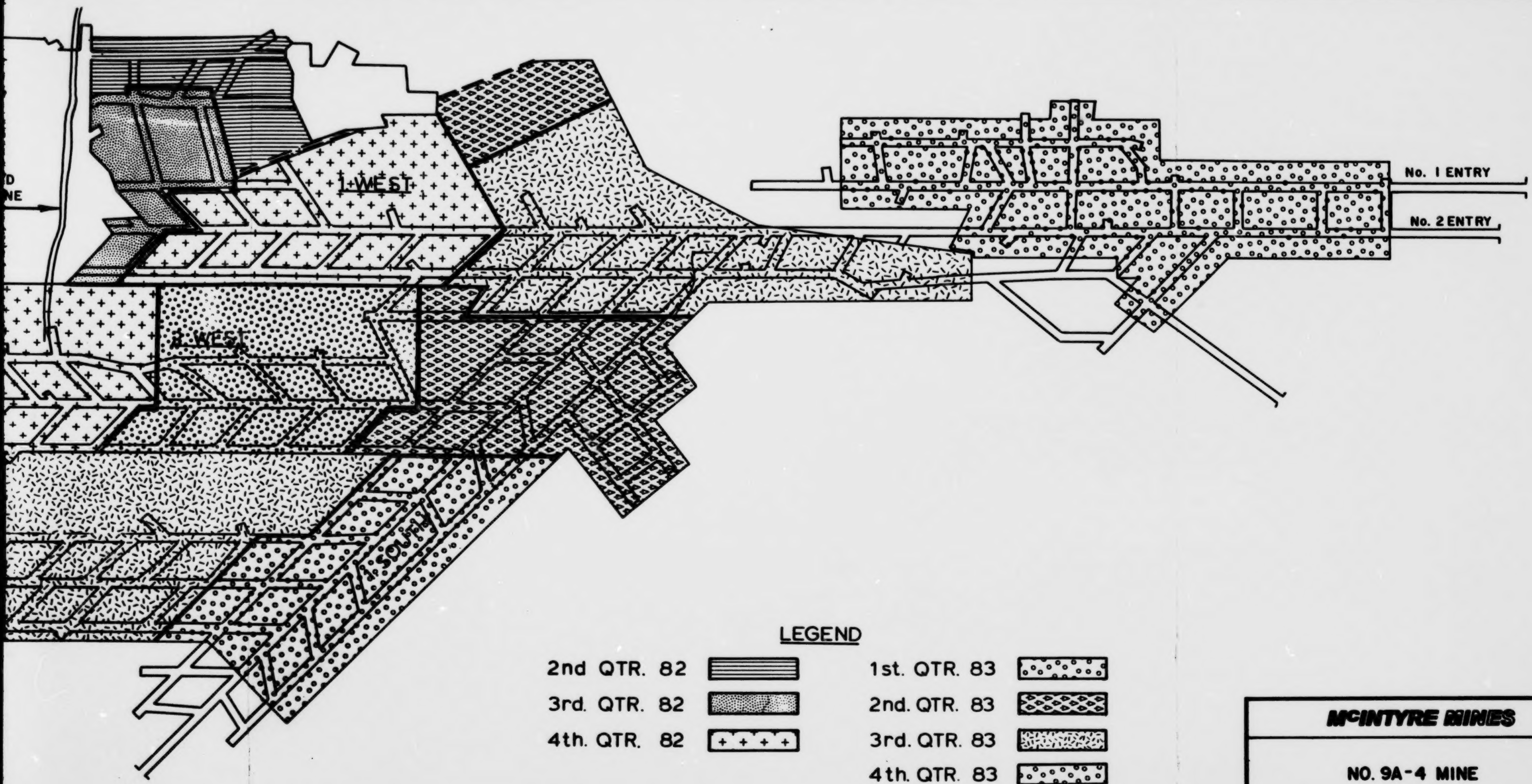
Nov. 1982

Fig. 4-1

0 200 400 600 800 1000 feet

75 150 225 300 metres


N
OBSERVED
BREAKLINE
MINED OUT AREA
1 WEST
2 WEST
3 WEST
SOUTH
2nd QTR. 82
3rd. QTR. 82
4th. QTR. 82



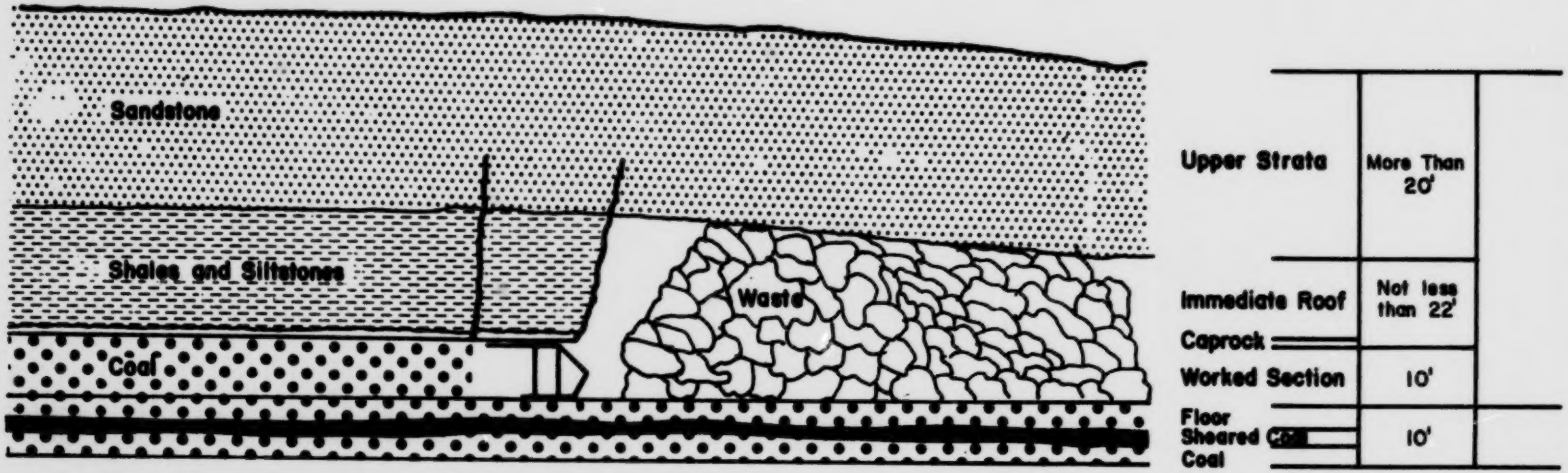
McINTYRE MINES

NO. 9A-4 MINE

NOV. 1982

FIG. 4-2

Scale: N.T.S.



SECTION OF LONGWALL FACE IN Nº 4 SEAM SHOWING:

1. Temporary support of immediate roof strata,
2. Immediate roof caving to fill the waste,
3. Upper strata bending and compacting the waste material,
4. Proximity of the sheared coal.

SHEARED COAL

Horizon: 12' to 16' below roof of seam

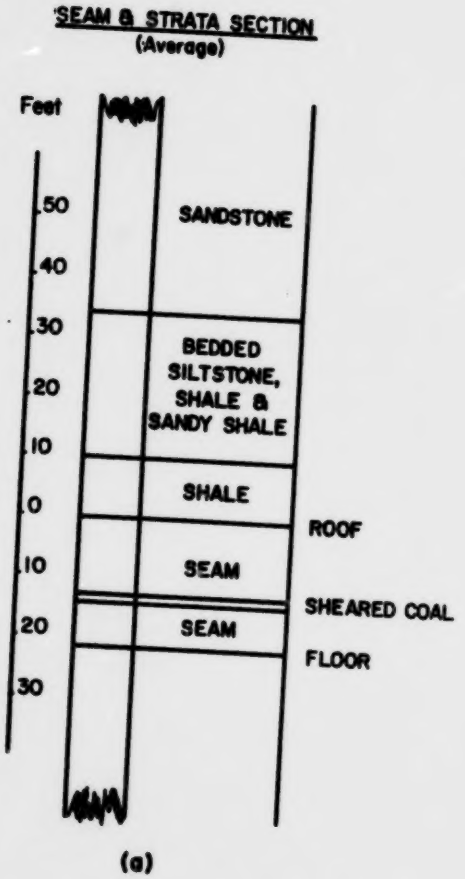
McINTYRE MINES

TYPICAL CAVING
PROCESS LONGWALL FACE

NOV. 1982

FIG. 4 - 3

Scale: N. T. S.


SEAM & STRATA SECTION
(Average)

(a)

STRATA SUPPORT CONTROL

For Equilibrium:

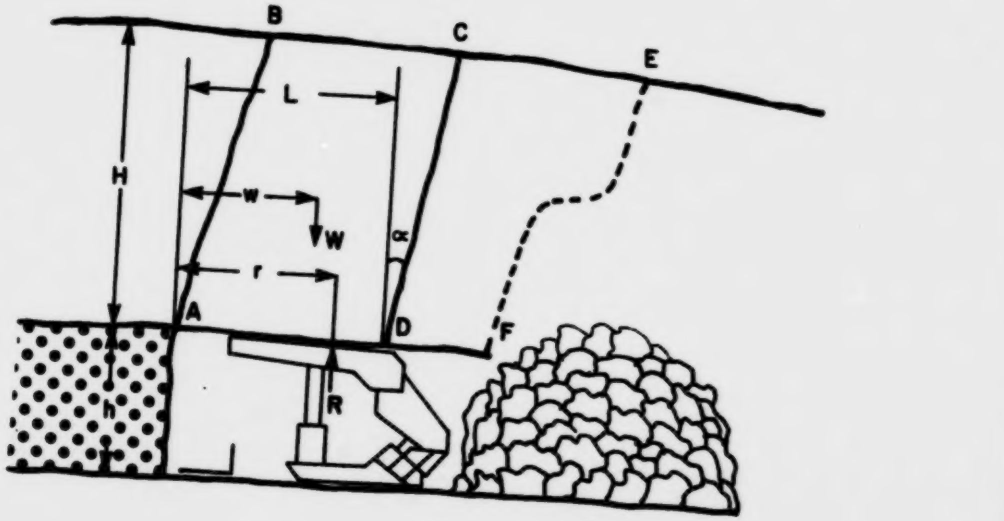
$R \times r = W \times w$ or $R = \frac{W \times w}{r}$

W = Total Dead Load on the Chock = $L \times H \times c \times d$

w = $\frac{L}{2} + \frac{H}{2}\tan\alpha$

c = Center Interval of Supports = 59"

d = Density of Immediate Roof = 2.53 to 2.57 tons/meter^3



(b)

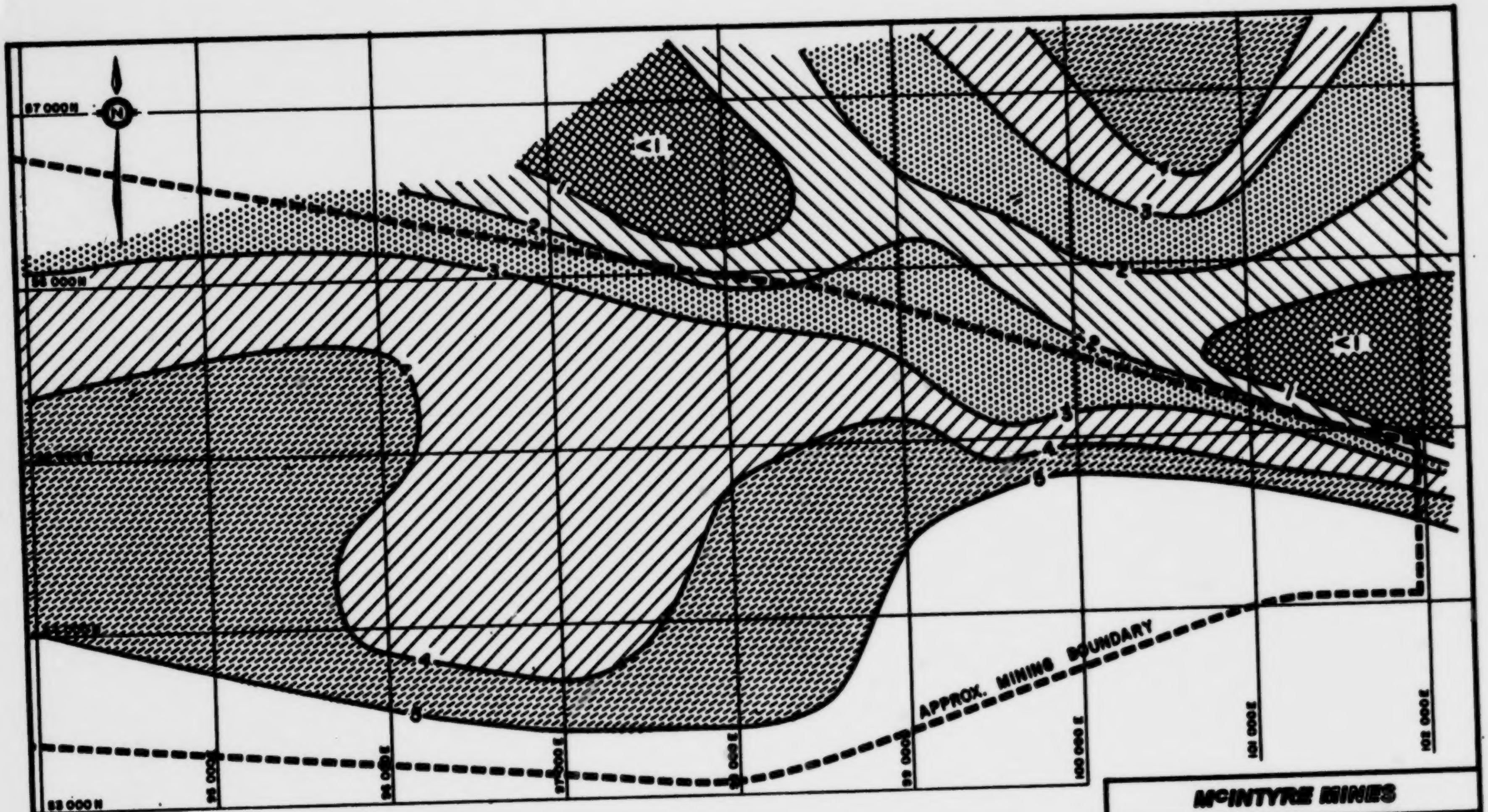
McINTYRE MINES

TYPICAL ARRANGEMENT FOR ROOF SUPPORT

NOV. 1982

FIG. 4-4

Scale: N.T.S.



LEGEND

- ▨ – BETWEEN 4 + 5 FEET IN THICKNESS
- ▨ – BETWEEN 3 + 4 FEET IN THICKNESS
- ▨ – BETWEEN 2 + 3 FEET IN THICKNESS
- ▨ – BETWEEN 1 + 2 FEET IN THICKNESS
- ▨ – LESS THAN 1 FOOT IN THICKNESS

100 0 100 200 300 400 500 metres
0 500 1000 1500 feet

NOTE: CONTOURS DERIVED FROM NorWest MAP 5

McINTYRE MINES

ISOPACH OF HARD COAL REMAINING
FOLLOWING
EXTRACTION OF TOP 10 FEET

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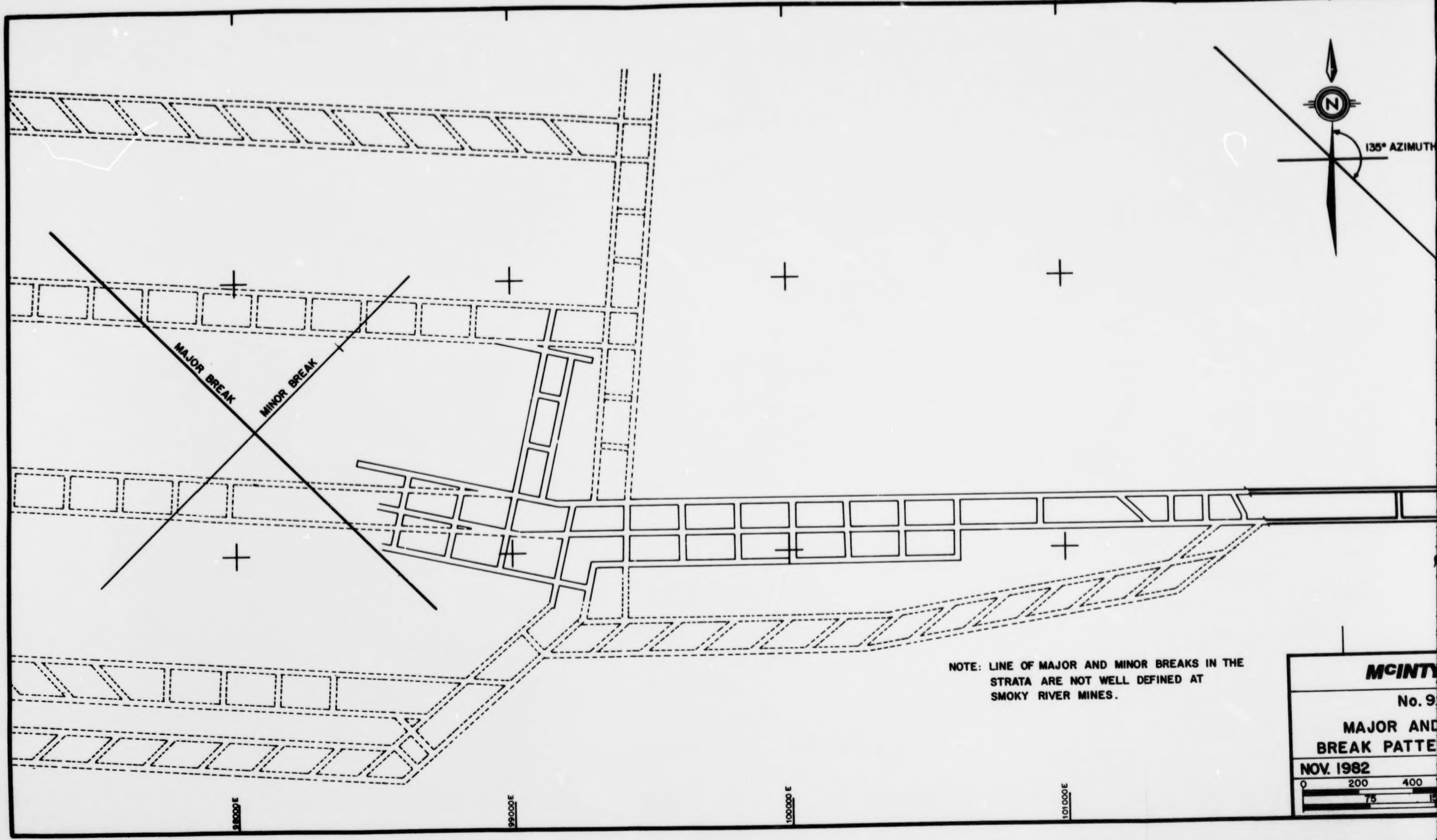
FIG. 4-5



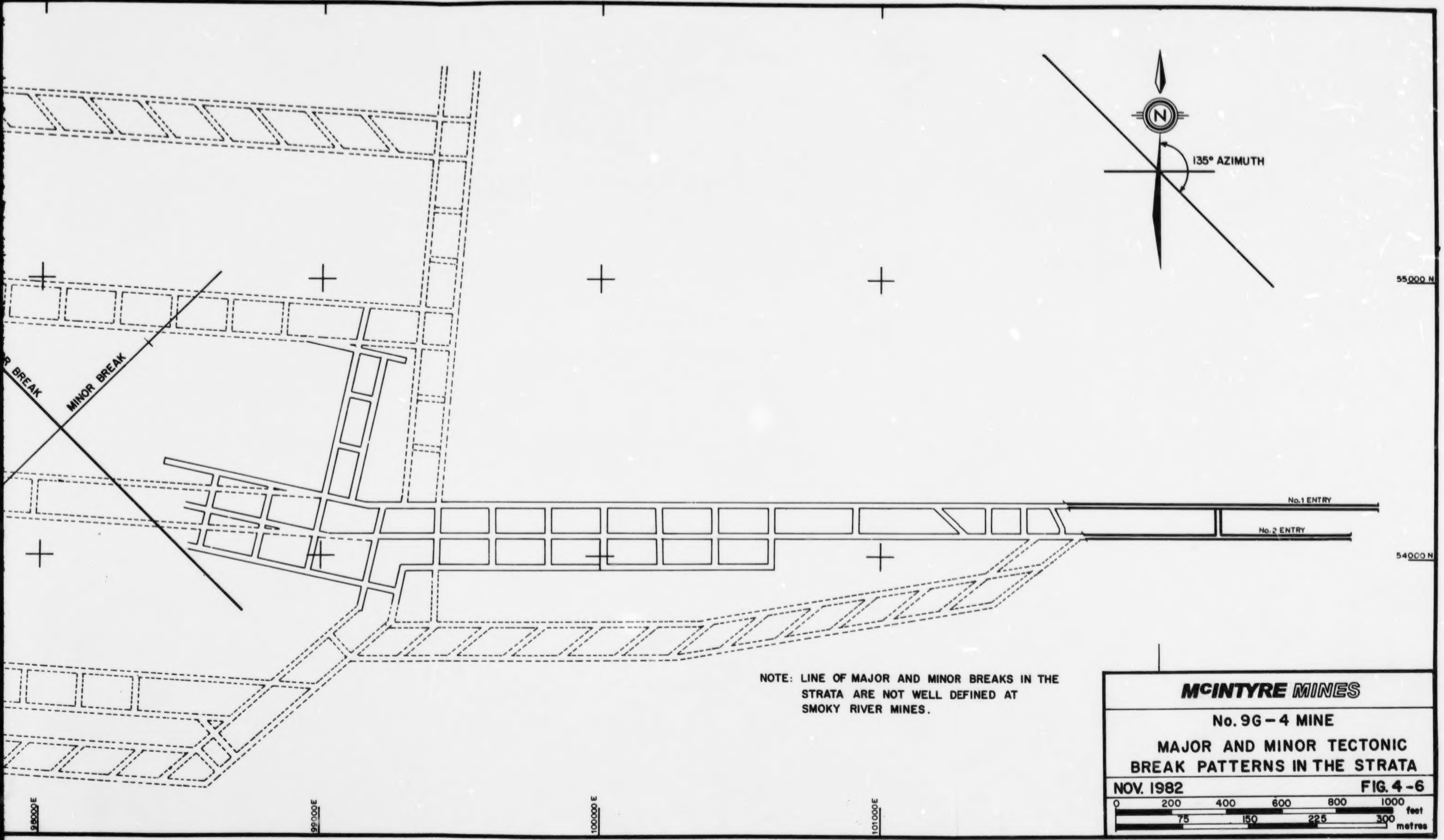
NOTE: LINE OF MAJOR AND MINOR BREAKS IN THE STRATA ARE NOT WELL DEFINED AT SMOKY RIVER MINES.

McINTY

No. 9

MAJOR AND
BREAK PATTE

NOV. 1982



NOTE: LINE OF MAJOR AND MINOR BREAKS IN THE STRATA ARE NOT WELL DEFINED AT SMOKY RIVER MINES.

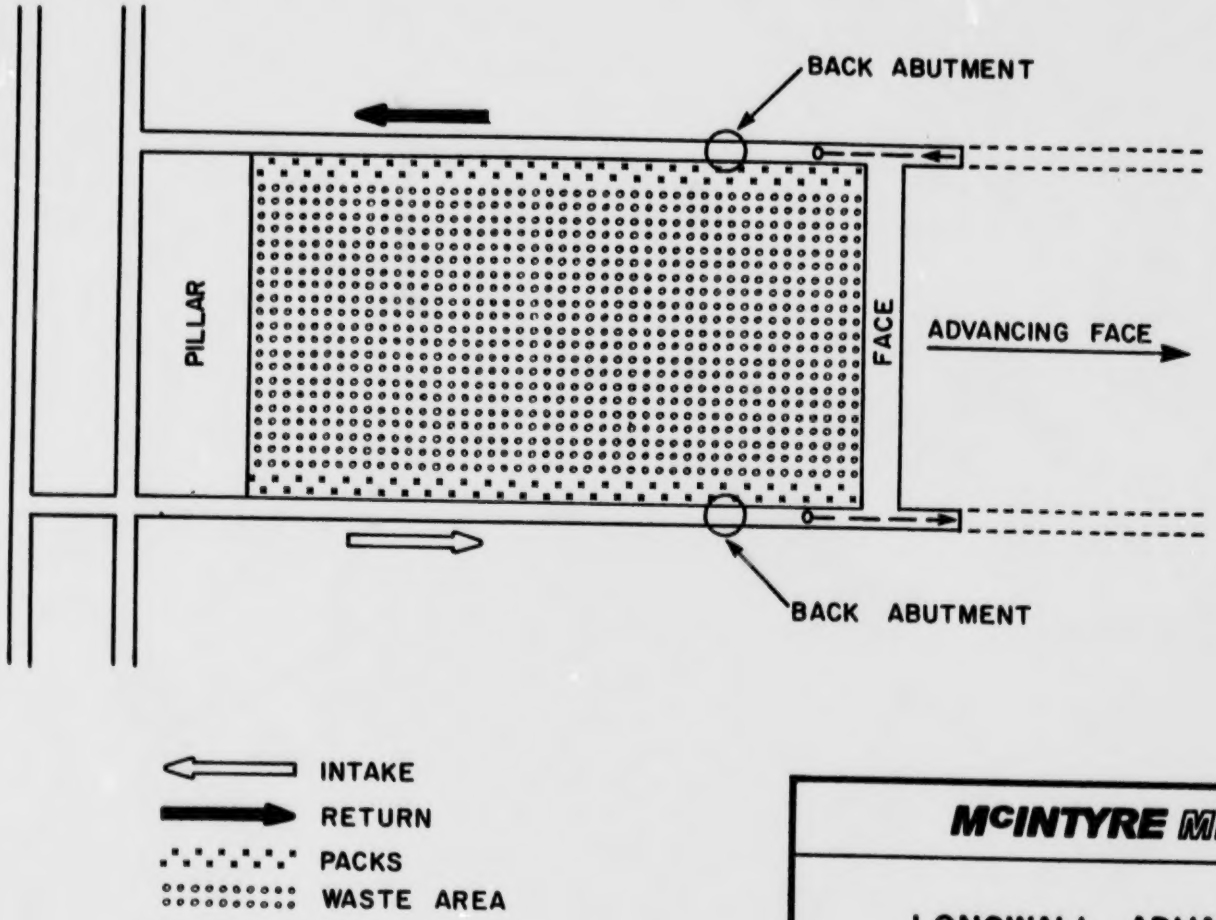
McINTYRE MINES

No. 9G – 4 MINE

MAJOR AND MINOR TECTONIC
BREAK PATTERNS IN THE STRATA

NOV. 1982

FIG. 4 - 6



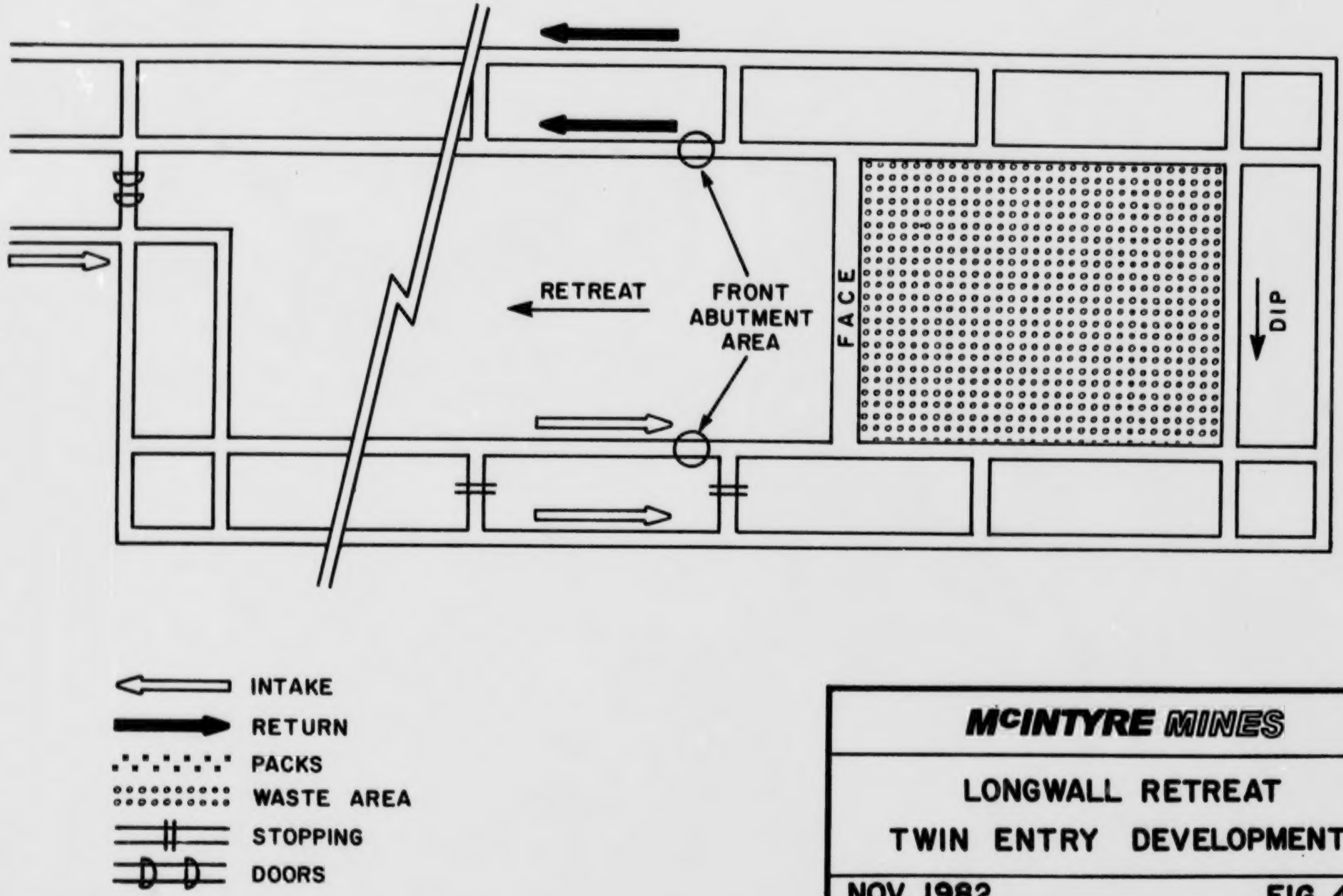
McINTYRE MINES

LONGWALL ADVANCING

NOV. 1982

FIG. 4-7

Scale: N.T.S.

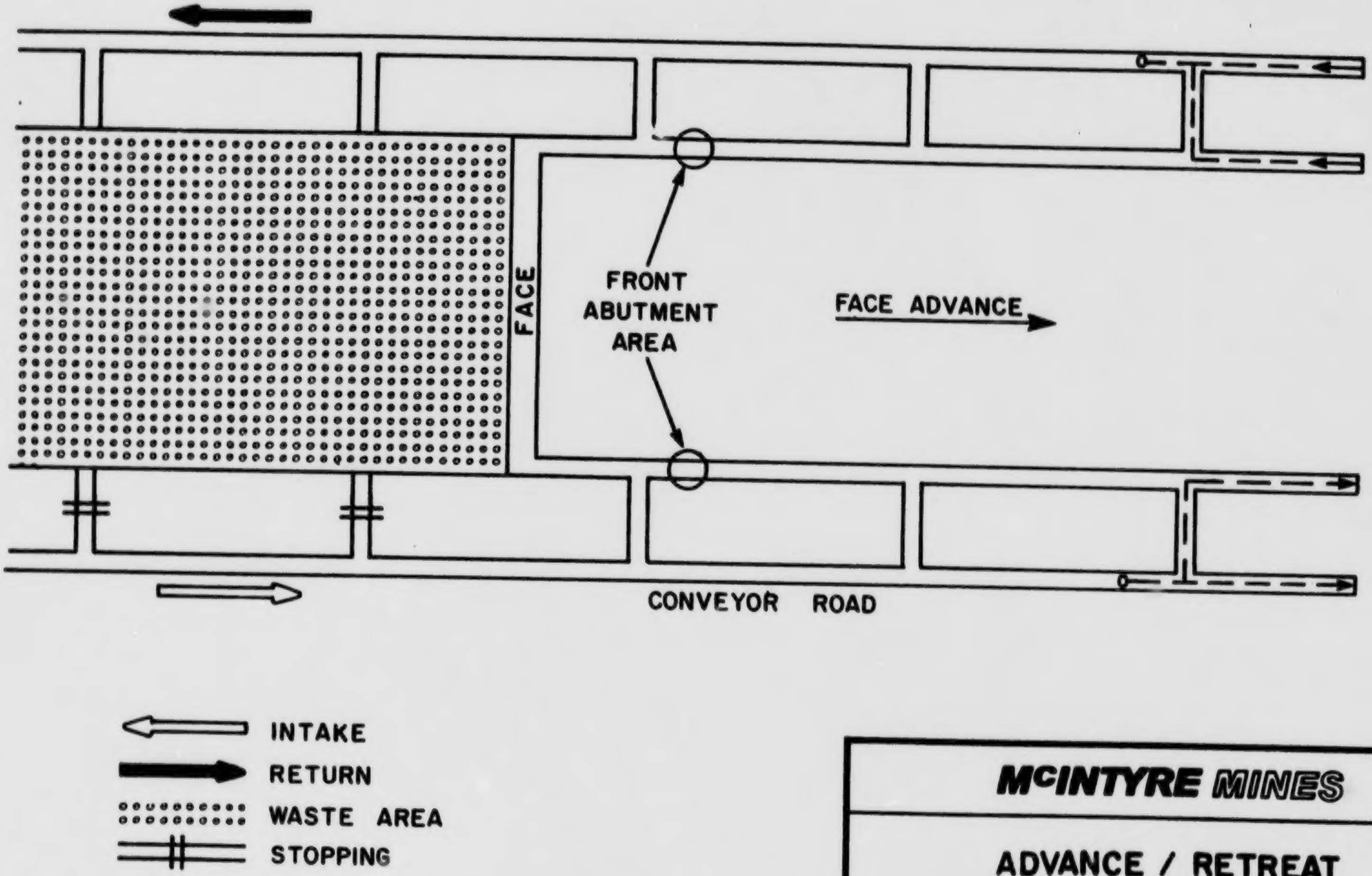


MCINTYRE MINES

LONGWALL RETREAT
TWIN ENTRY DEVELOPMENT

NOV. 1982
FIG. 4-8

Scale: N.T.S.



McINTYRE MINES

ADVANCE / RETREAT
TWIN ENTRY DEVELOPMENT

NOV. 1982

FIG. 4-9

Scale: N.T.S.

McINTYRE MINES LIMITED

LONGWALL DEMONSTRATION
PHASE 1

SECTION 5 DESIGN FOR NO. 9G-4 MINE

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(Following Tables)

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5.0 LONGWALL DESIGN FOR NO. 9G-4 MINE

5.1 INTRODUCTION

In Section 5 the detailed design for longwall in No. 9G-4 Mine is undertaken, based on parameters developed in Section 4.

5.2 ACCESS

5.2.1 Services

Any longwall layout would require similar services in terms of transport and ventilation. The existing roadway system in No. 9G-4 Mine imposes some limitations to the transportation of large pieces of equipment and to the ventilation.

Transportation

Currently the mine operates diesel vehicles for supplies transportation. This system cannot be extended for use into areas with grades in excess of 10° to 12° without significant modification. In order to retain the benefit of flexibility and current operating expertise grades for transportation of men and materials will, where practical, be minimized.

Ventilation

When the longwall is operating it is estimated that a minimum air supply of 200 000 cfm would be required. To achieve reasonable air velocity and tolerable pressure losses a third roadway would be required that could be connected to the surface at a later date to further improve ventilation and access to the more distant reserves.

Services Design

To effect the required improvement in transportation and ventilation one of four alternatives could be employed:

- The existing supplies entry could be enlarged for a distance of some 570 ft. This would eliminate the section which contains a severe change in grade and provide an adequate transportation route with grades of approximately 10°. While this would satisfy the transport system, it would not provide additional ventilation capability and could only be achieved at the expense of severe operating difficulties during construction (Figure 5-1.1).

- An additional entry could be driven from the surface to connect with the left hand road of 1 West Development. This would provide good transportation and ventilation facilities but would require approximately 1400 ft of hard rock drivage. This development would serve current and future mining requirements and is probably the ideal solution (Figure 5-1.2).

- The left hand road of 1 West Development could be driven back in-seam at a maximum grade of 8% to connect into the existing No. 2 roadway. This would provide good transportation and ventilation facilities for exploitation of current reserves but would require approximately 700 ft of hard rock drivage. For exploitation of additional reserves a connection to the surface would still be required (Figure 5-1.3).

- A pair of roadways could be driven in-seam (Figure 5-2). This would provide adequate transportation routes and ventilation for recovery of existing reserves but would require connection to the surface for recovery of additional reserves. This is the least costly development since existing equipment, mining techniques and manpower could be employed and no hard rock mining would be necessary.

To provide the required transportation route and ventilation capacity two roadways will be driven in coal to intersect the No. 2 access entry (Figure 5-2).

5.3 PANEL LAYOUT

Various layouts for retreat working have been reviewed in terms of pillar size, development entry systems and configuration.

5.3.1 Pillar Size

With multiple entry drivages, the dimensions of pillars between development roadways must be chosen to ensure that mining can proceed efficiently and safely with maximum resource recovery.

To maximize recovery both sets of roadways developed for the extraction of Panel 1 will be used for subsequent panels.

Pillars have been designed to ensure that:

- They are capable of withstanding the side abutment pressure produced during development.
- Following extraction of the first face they do not yield under the front abutment pressures from the extraction of the first panel.
- They yield in a controlled manner under the abutment pressure produced by the second panel to minimize floor heave.

Calculations indicate that the appropriate pillar size for the duty is 120 ft by 300 ft (Appendix 3-4). These dimension have been adopted.

In addition to appropriate pillar sizing, additional roadway support will be provided as required in the abutment pressure areas during mining operations.

5.3.2 Single Entry

Although single entry has been rejected for this particular application it should not be excluded from consideration when the exploitation of other reserve areas are being considered. Therefore, for completeness, Figures 5-3 and 5-4 showing mining layouts using the single entry development system have been prepared.

5.3.3 Twin Entry

Retreating to Full-Dip

Figure 5-5 shows a layout with main trunk roads located along the base of the syncline. A series of twin entry drivages with 120 ft supporting pillars spaced at 550 ft between adjacent developments would be driven up-dip to a location adjacent to the top of the anticline. The faces would be formed by connecting the drivages and longwall operations would retreat to-the-dip.

The face line would be on-strike and mined coal would be transported down-grade to the main conveying system.

The layout would provide longwall panels with a run of about 2100 ft and the coal reserve could be systematically extracted by working inbye or outbye.

The problems associated with this layout include:

- Short panel life and hence a requirement for frequent transfer of equipment between faces.

- The position of the base of the syncline must be accurately located to allow long life roadways without deviation to be developed, particularly if additional reserves to the west of the area are to be exploited.
- Variations in inclination of the coal seam (up to 25°) would make the development of roadways extremely difficult. This is not possible with mining equipment presently available at the mine.
- At inclinations greater than 10° roof breaking in the waste may move forward onto the supports.
- Any water from the strata or mining operations tends to accumulate at the face. With a coal floor this may cause problems.
- As the gradient increases horizon control becomes more difficult.

Retreating To-the-Rise

Figure 5-6 shows a layout with main trunk roads along the top of the anticline. A series of twin entry developments with 120 ft supporting pillars spaced at 550 ft between adjacent developments would be driven down-dip. The faces would be formed by connecting the drivages and longwalls would retreat to the rise.

The face alignment would be on-strike and mined coal would be transported up-grade to the main conveyor system.

This layout would provide longwall panels approximately 2100 ft long and the coal reserve could also be systematically extracted by working either inbye or outbye.

This layout has two major advantages:

- Water runs into the waste area and is not a serious problem.
- The roof caving in the waste falls away from the supports.

There are still disadvantages of short panel life, difficulty in development at grades in excess of 15° and identification of the top of the anticline. In addition:

- To control methane liberated at the face may require the establishment of a back airway system to prevent accumulation over electric drive units of the face conveyor.
- Coal will tend to spall off the face and face sprags may have to be set to effect control.

Retreating Along-the-Strike

Figure 5-7 shows a layout with main trunk roads capable of providing access to additional reserves to the west located adjacent to the top of the Drill Camp Anticline. A series of twin entry drivages with 120 ft pillars spaced at 550 ft between adjacent developments would be driven to an arbitrary boundary some 5000 ft along-strike. The faces would be formed by connecting the drivages and longwall operations would retreat along-strike with the face equipment operating on dip. Mined coal would be transported down-grade to the main belt conveying system.

For this layout the panel in the centre of the area would be developed first. The face gradients would be on average between 4° and 18° while the development roads dip inbye at about 4°. These are the least severe gradients expected in the area and would allow the first panel to be worked under the best available conditions.

Correct alignment for the development of Panel 2 and the main trunk routes for access to additional reserves to the west can be assured by determining the location of the top of the anticline at the inbye end.

This would be carried out by driving headings to the south from the Panel 1 face-line.

The problems associated with this layout would assume significance only if the seam gradient becomes significantly more than projected. The roadway profile would be more difficult to form and support in steeply inclined strata, particularly if the immediate roof strata is to remain undisturbed.

To avoid relocation of the conveyor structure following development the conveyor should be located in the road adjacent to the coal face. This may cause problems in supplies transportation if water is present in the lower roadway.

The benefits of the layout include:

- Long panel runs and hence reduced requirement for equipment transfer between faces.
- Waste caving and support movement can be readily achieved.
- An antitropal ventilation system can be employed to assist methane migration off the face.
- If a back airway system is required it can be readily accommodated.
- Faces can be operated to retreat either inbye or outbye.
- Roadway conveyors are relatively level.

Table 5-1 summarizes an evaluation of selected activities related to the direction of mining as applied to the No. 9G-4 Mine.

5.3.4 Recommended Layout

The layout with development roadways driven along-strike and longwalls operating on dip, retreating along-strike has been selected as the most appropriate (Figure 5-7), for the following reasons:

- The first face can be developed with existing equipment and can commence operation within some 9 months.
- The life of each panel will be about 12 months with fewer transfers of equipment than other layouts, producing the maximum tonnage between equipment transfers.
- The mining configuration with faces on dip, retreating along-strike is well established.
- Ventilation arrangements are simple.
- Face equipment is installed at the furthest point of development in good conditions and retreats outbye making equipment recovery relatively simple.
- Water will flow away from the face-line to the lower roadway allowing easier control.
- Existing free-steered diesel powered vehicle transportation systems can be used.
- Entries to districts are direct, reducing ventilation resistance and allowing long conveyor runs.
- Replacement faces can be readily completed in ample time.

The principal characteristics of a typical longwall panel will be:

- Development system	2-entry
- Face length	550 ft
- Extracted height	10 ft
- Pillar width	120 ft
- Direction of mining	Retreat/faces on dip
- Panel Run	4800 ft

5.4 SUBSIDENCE AND SEAM INTERACTION

5.4.1 Introduction

When coal is extracted and the adjacent strata is induced to cave into the mined-out area, the total strata above the seam usually subsides. The extent of the subsidence is time related and depends upon the thickness of coal extracted, the area extracted, the rate of extraction, the type of support left in the worked area, the depth of the seam below the surface, seam inclination and the nature of the strata above the seam. During subsidence both horizontal and vertical movement will occur inducing strain in the strata.

Surface movement resulting from subsidence can have a significant impact on surface structures and sub-surface movement of the strata may affect the potential for recovery of coal seams located above the seam being mined. However, longwall mining with fully caved waste areas usually produces the most uniform and manageable subsidence pattern.

As a basis for assessment of the likely effect of subsidence on the surface and on the mineability of Seam #10, terminology, data and formulae derived from subsidence studies in the UK and Australia have been used since little relevant data is available for the Rocky Mountains.

It has been assumed that the effects of mining Seam #4 at Smoky River will be similar to those experienced elsewhere, although subsidence profiles taken in the Seam #11 beltway during depillaring below in Seam #4 showed less severe convergence than that calculated by UK methods (Bielenstein, et al).

The Subsidence Engineers Handbook (National Coal Board 1975), has been used to estimate the likely subsidence (Figure 5-8). In addition reference has been made to the paper entitled "Multi-Seam Mining at Smoky River" (Bielenstein, Wright and Mikalson).

5.4.2 Effect on Seam #10 of Mining Seam #4

The degree of disturbance in any particular area is normally related to the width of the working and depth below the surface. In certain circumstances the total subsidence experienced may reach as much as 0.9 times the extracted thickness. It should be noted however, that when considering the extraction of coal seams above the extracted seam the areas of concern are related to the slope area where strata is subject to induced stresses in the vertical and horizontal plane (Figure 5-9). In many instances subsequent mining activity can be successfully conducted by correct choice of working zones.

The angle of draw for seams inclined at 18° has been determined as 16° to the rise and 54° to the dip. The subsidence profile for Seam #10 which is located some 200 ft above Seam #4 has been derived and is shown in Figure 5-10.

An examination of this subsidence profile indicates that if longwall mining were adopted faces of 350 to 400 ft could be worked in the de-stressed fully subsided areas of Seam #10. If a decision to proceed with extraction of Seam #10 is taken, the best position for roadway and face locations in this seam could be readily determined from an exploration drivage located parallel to the original face-line in Seam #4. This roadway will clearly identify the stressed and de-stressed areas and a suitable layout could be designed based on the information derived.

5.4.3 Surface Effects of Mining Seam #4

The surface will be subjected to subsidence over an area greater than that worked underground. Stress will be developed as the workings move across the area and a break may occur. The potential effect on the surface has been calculated and is shown in Figure 5-11. For this calculation an average seam cover depth of 1200 ft has been chosen. No allowance has been made for surface gradients as the variations in depth of working and gradients are compounding. This shows that the final surface profile may be lowered by some 9 ft over the mined areas.

In the area to be worked the surface subsidence effect will be of minor consideration. There are no surface structures of importance and no special arrangements will be necessary.

5.5 HAULAGE AND TRANSPORT

5.5.1 Introduction

The haulage and transport system must be designed, installed and operated to ensure that the demands imposed by the mining systems during development and longwall operations can be satisfied in a safe and efficient manner. A reference plan for activities is outlined in Figure 5-12.

5.5.2 Operating Experience

In all underground mines previously and currently operated at Smoky River, conveyor systems have been used exclusively for coal transportation and free-steered vehicles for supply purposes.

The introduction in 1980 of diesel powered multi-purpose free-steered vehicles, in addition to the battery-powered fleet has demonstrated the viability of this system and provided enhanced flexibility and capacity. To date, manriding of personnel to and from the working place has not been practiced but the potential for manriding using the conveyor systems has been evaluated.

5.5.3 Coal Transportation

The existing system installed in the No. 9G-4 Mine utilizes belt conveyors which deliver coal to an 8000 ton stockpile at the surface. Belt conveying systems are well proven and mine staff are familiar with conveyor operations. While alternative systems for coal transport such as tub and rail, pneumatic or hydraulic are available the installation of such a system would require significant capital expenditures and new techniques with little measurable benefit. Consequently they have not been considered in depth and the conveyor system will be retained to maximize the use of available equipment and expertise.

The main trunk conveyor is 48 inches wide and runs at 600 fpm and is powered by two 200 HP motors. This conveyor is capable of conveying coal at 1200 tons per hour and is adequate for the proposed duty. Extensions to the conveyor system will be similarly rated. Transfer points will be constructed to ensure smooth transfer of coal with minimum dust generation and each conveyor will be equipped with the appropriate signalling and control systems to ensure compliance with relevant statutes.

The proposed conveyor routes and details for both initial development and longwall operations are shown in Figure 5-13.

5.5.4 Supplies Transportation

The maximum distance from the surface to the longwall face is approximately 10 500 ft. Access to the faces will be along district roadways inclined at about 5° with gradients in cross-cuts at up to 15°. Main roadways will require equipment to negotiate grades at less than 10° (Figure 5-14).

Routine supplies range from small items such as roof bolts to 12 ft wooden props with occasional heavy items such as replacement units for mining machines.

During installation of the longwall face and transfer of equipment between faces large bulk loads of up to 20 tons must be transported. Supplies vehicles used for routine duties could not be used for this type of operation and special equipment will be purchased.

There are a number of suitable material haulage systems available:

- Rope haulage using rail mounted bogies.
- Rope haulage using trapped rail systems.
- Diesel/battery powered systems using either trapped or conventional rail.

- Monorail systems either suspended or floor mounted operated by rope systems or with diesel powered prime movers.
- Free-steered trackless systems either battery or diesel powered.

Although each system claims particular advantages such as speed, convenience, ability to negotiate adverse grades, etc. all systems with the exception of free-steered vehicles require the installation of permanent guide or support equipment and are therefore relatively inflexible and tend to be expensive to install and maintain.

Experience shows that, where conditions are suitable for their use, a supply system which employs free-steered vehicles is superior to other systems for the following reasons:

- Low initial capital cost.
- Flexibility.
- Loads can be transported directly from the stockyard to the working area without trans-shipment.
- No permanent installations are required in the roadways.
- While running and maintenance costs may be higher than some systems no additional equipment is required to extend the system if travelling distances are reasonable.

Of concern will be the ability to provide supplies to the third face. The section of roadway identified as 2 North Development will have an inclination in excess of 10° and up to 25° in places for a distance of some 700 ft. Special arrangements will be made for this section.

5.5.5 Recommended System

Because there are no significant advantages to be gained by employing other systems it proposed to continue the use of conveyors for coal transportation and diesel powered free-steered vehicles for supplies duty at No. 9G-4 Mine. Where steep grades (+15°) are likely to be encountered such as 2 North Development, alternative resolutions to the problem will be sought at the appropriate time. To ensure that roadway conditions can be maintained a diesel powered roadway grader specifically designed for use in underground mines will be employed.

Vehicles designed for the transport of large items of equipment such as roof supports, and for the transportation of men will be employed.

5.6 VENTILATION

5.6.1 Introduction

Statutes require that sufficient air must be available at all parts of the mine to dilute and render harmless all noxious and flammable gasses. The ventilation system must also ensure that acceptable environmental conditions are maintained, with particular attention to the level of respirable dust.

In Western Canadian conditions an air heating system is usually required to ensure that the air temperature in the mine remains at acceptable levels during the winter.

Mine ventilation can be achieved by either forced or exhausted air systems. The forcing system applies a positive air pressure to one of the mine entries by means of a forcing fan system to circulate the air through the mine before exhausting to atmosphere. In an exhaust system a negative pressure causes air to flow into the mine, around the workings and out via an exhaust fan located in an air lock in a second exit. Either system can be successfully applied and it is recommended that the exhausting system currently employed be retained.

5.6.2 Operating Experience

At all mines previously and currently operated at Smoky River the exhaust ventilation system has been applied and has proven satisfactory. Mine air heaters are constructed adjacent to the main intake airway to increase the temperature of air entering the mines during the winter months.

At No. 9G-4 Mine the arrangements for the main ventilating system are in place and have been designed to accommodate any additional ventilation requirements for longwall operation (Figure 5-15).

During operations to date at No. 9G-4 Mine the quantity of methane liberated during drivage operations has been low and readily diluted to acceptable levels by the ventilation systems. Methane concentrations of less than 0.2% in the general air body when ventilated with approximately 20 000 cfm are typical.

Concentrations of respirable airborne dust in the atmosphere have been controlled to statutory requirements either by the application of water sprays and/or by appropriate location of auxiliary ventilation system exhaust fan air ducts.

5.6.3 Development Ventilation

Figure 5-16 shows the mine ventilation system for the initial development activity and Figure 5-17 shows the ventilation system for the development headings.

To achieve the required standards for dust concentration in the general air body each heading would need to be ventilated at the rate of 11 000 cfm. The air quantity for dust control is based on a required forward air velocity of 70 fpm. At speeds lower than this dust would back up against the ventilation and cause high concentrations in the locations of the operators. This quantity will also be sufficient to disperse any methane or other noxious gasses that may be encountered.

As the headings are developed fresh air will enter along the lower of the two headings and be induced to flow to the development face by the use of an auxiliary exhausting ventilation system.

As cross-cuts are developed the auxiliary fan system will be advanced and stoppings will be installed in the vacated heading to provide a secure air seal between intake and return roadways. Such stoppings will be fireproof.

5.6.4 Longwall Ventilation

The longwall face is designed to produce coal at over 4000 tons per day. This may liberate considerable quantities of methane during mining operations and since the waste will be fully caved behind the face methane may also migrate to the face-line from the adjacent Seams #10 and #11.

It is difficult to assess the magnitude of this potential migration, therefore it is important to ensure that an adequate quantity of air is available to disperse the methane. The system will be designed to provide 60 000 cfm for ventilation of the longwall. Experience at other mining operations indicates that it is unlikely that this quantity will be required and that normally 30 000 to 40 000 cfm will prove adequate.

Figure 5-18 shows the ventilation system for extraction of the first panel and development of the second. Figure 5-19 shows the ventilation system for extraction of the second panel and development of the third.

5.6.5 Spontaneous Combustion

While many opportunities for spontaneous combustion have been present, no occurrence of spontaneous combustion has ever been noted in previous mining activity in Seam #4 at Smoky River. Provided reasonable standards of mining practice are followed the risk of such an occurrence is considered to be negligible.

5.6.6 Main Ventilation

The maximum requirement for ventilation air quantity will occur when a longwall face and one development unit are operating. To provide adequate ventilation for those two activities will require approximately 100 000 cfm at the operating locations, comprised of 60 000 cfm for longwall operation and 40 000 cfm for development (Figure 5-20).

In order to provide the required volumes of air two additional roadways (No. 3 and 4) will be driven (Figure 5-2). At a later date these roadways may be connected to the surface to further improve ventilation capability.

In order to achieve the required ventilation levels at a volumetric efficiency of 50%, fan capacity to provide approximately 200 000 cfm will be installed at the mine surface.

5.7 FIRE FIGHTING AND DUST SUPPRESSION

The water supply system must accommodate the demands of both firefighting and dust suppression.

The dust suppression system must be capable of supplying water on demand during mining operations at approximately 120 gpm and at flow pressure of 400 psi.

The firefighting system must ensure an adequate supply of water at all times even during a power failure. Care must be taken to ensure that the water pressure in the system is such that hand held hoses can be readily and safely used (Appendix 2-3).

5.7.1 Water Supply

The mine is located in mountainous terrain at an altitude of 4000 ft. No free flowing source of surface water is readily available. The nearest source for such a water supply is Sheep Creek approximately 1 mile distance and at an elevation of some 1000 ft below the mine entrance. Currently the water required for bathhouse facilities and mining operations is obtained from two wells and from within the mine. The water from one well at approximately 15 gpm is used to supply the bathhouse requirement and a second well is used to supplement water from Seam #10 for underground mining operations.

Flow measurements show that approximately 65 gpm of water will be available for use on dust suppression and firefighting. Approximately 15 gpm can be obtained from the second well and 50 gpm from Seam #10.

The estimated water quantity available daily is 93 600 gallons.

A water storage and pumping facility suitably protected against the extremes of temperature likely to be encountered will be provided to accommodate the fluctuating demand for dust suppression water and minimum standby capacity for firefighting (Figures 5-21 and 5-22). Table 5-2 provides a typical control sequence to maximize water storage capability.

To ensure that the water supply from the underground mine is free from contamination all water will be conducted to a large capacity storage area located adjacent to the bottom of the access drifts so that suspended solids may settle out before the water is pumped to the surface storage (Figure 5-23). Facilities for regular cleaning of the sumps form an integral part of the design for the pumping station. A single line drawing of the proposed installation is shown in Figure 5-24.

5.7.2 Water Requirements

Based on anticipated consumption rates the following estimate of total daily water requirements has been calculated.

Shearer:	
90 gpm x 10 shears x 65 minutes per shear =	58 500 gallons
Continuous miner:	
40 gpm x 6 hours x 60 =	14 400 gallons
Sprays, etc:	5 000 gallons
Total daily water requirement	77 900 gallons

The available water supply at 93 600 gpd should be adequate to meet the dust suppression needs.

5.8 POWER SUPPLY SYSTEM

The main power supply to the mine is provided by a 25 kV overhead line system originating at the Milner Plant distribution substation adjacent to the main service complex.

At the surface of No. 9G-4 Mine a transformer with a maximum capacity of 5 MVA is installed which transforms the voltage from 25 to 6.6 kV for distribution in the underground mines.

In addition a 1 MVA transformer transforms the voltage from 25 kV to 550 volts for general surface distribution and utilization.

Both transformers have star connected secondary windings and are equipped with a neutral resistance to limit ground fault current flow.

5.8.1 High Tension Systems

Throughout the mine a standard type and size of cable and cable coupler is used for the HT distribution system. The cable used is rated at 8 kv and is of type SHD construction with size 3/0 conductor. This cable construction provides an individual ground screen around each conductor and three additional uninsulated ground conductors (Appendix 2-8).

When employed with suitable switchgear and protective devices this cable minimizes the potential for high energy phase to phase faults.

Cable couplers used are of flameproof design manufactured by BICC and rated at 300 amp capacity.

To obtain the required voltage for utilization suitably rated flameproof transformers manufactured by Brush and equipped with multiple outlets at the low tension end will be used.

5.8.2 Low Tension Systems

Utilization voltage within the No. 9G-4 Mine would be 550 volts for development and anciliary operations, and 1100 volts for the longwall face.

The interconnecting cables between transformer and control switchgear would be rated at 2.2 kV for both 550 volts and 1100 volts. Such cables would be of Type SHD construction and of a minimum 3/0 conductor size, mechanically similar to the HT distribution cables.

Cable couplers would be flameproof of BICC manufacture and rated at 300 amp.

Control switchgear would be of flameproof design and appropriately sized for the required duty. Where possible switchgear manufactured by Wallacetown Engineering Co. would be employed for compatibility (Appendix 2-8).

Cables used to supply the motors would be appropriately sized and of Type SHDGC configuration (Appendix 2-8) rated at 2.2 kV for use at voltages up to 1100 volts. This cable construction, in addition to providing a grounded screen around each conductor, provides an insulated conductor for remote control of contactor operation.

Cable sizes would be:

- Miner, shearer and trunk conveyor belt for longwall 3/0
- Longwall face conveyor 2/0
- Equipment used in development and elsewhere, stage loader and crusher #2 AWG

Cable terminations would be flameproof and compatible with switchgear and motor sockets.

Motors used would be of flameproof construction and suitably rated for the proposed duty. Apart from the shearer motor, which would be water cooled, all other motors employed on the longwall would be of the totally enclosed fan cooled type. Where necessary motors with high starting torque characteristics would be employed.

Figures 5-25 and 5-26 show schematic arrangements of the power supply systems for initial development activity and longwall operations as well as the equipment locations.

5.8.3 Communication and Monitoring

Communications and monitoring systems would be intrinsically safe, with longwall communications and control systems manufactured by Davis of Derby (Appendix 2-8). This system is self monitoring and can be integrated into the motor control systems to provide lockout and prestart alarm facilities.

Equipment capable of providing remote indication of the operational state of longwall equipment is available if required.

5.8.4 Voltage Regulation

The torque produced by a motor is significantly influenced by the voltage available at the motor terminals. It is therefore necessary to ensure that the supply system is capable of accepting the electrical loads without undue fluctuations in voltage, particularly at start-up.

Calculations (Appendix 4-2) show that the proposed supply system is adequate and that at 1100 volts, voltage regulation problems will not be of concern during operations provided that main power supply transformers are maintained within 300 ft of the longwall face.

5.9 DRAINAGE AND WATER CONTROL

5.9.1 Introduction

To minimize adverse effect on mining conditions which may result from ingress of water into the working areas a water control scheme must be implemented.

5.9.2 Operating Experience

Room and pillar mining operations in both No. 9A-4 and No. 9G-4 Mines have been subject to minor difficulties caused by the ingress of water into the working area. Water ingress has usually been confined to within 300 ft of the heading faces. As the developments advance the water follows the development and dries out in the roadways behind the drivages. Quantities of up to 50 gpm have been encountered.

5.9.3 Control

Based on experience at No. 9A-4 and No. 9G-4 Mines a pumping scheme capable of handling up to 150 gpm (50 gpm per heading) will be required during development. Longwall operations may result in an increase in water quantity though this is unlikely since water contained in any aquifers will have been drained during the development activity. To ensure that good working conditions are maintained during development:

- Water will not be allowed to drip onto the floor of the heading but will be conducted across the roadway to a low side flume and into a sump.
- Water at the face of the heading will be removed to a sump by means of a suitable pump.
- Sumps will be provided of sufficient capacity to allow the settlement of solids and controlled pumping operations. Sumps will be constructed such that they are readily accessible to allow sump cleaning, pump replacement, etc.

As each district develops additional sumps would be constructed and a 4 inch diameter pump range installed in the conveyor roadway. This pump range would also be used for water control during longwall operations.

Figure 5-24 shows a general arrangement of the proposed pumping scheme for water control. Water will be pumped initially from district sumps to the main mine sump located adjacent to the base of the access drifts and then to a surface reservoir for use as firefighting and dust suppression water during mining operations.

During longwall operations the faces will retreat to-the-rise at approximately 4°. This will allow excess water to flow away from the face into the waste area.

If larger quantities of water than anticipated are encountered on the longwall suitable pumps will be installed near the stage loader.

5.9.4 Pump Requirements

To effect proper water control several different types of pumps would be required. Table 5-3 outlines typical pump performance specifications. Table 5-4 shows a list of pumps presently in use at Smoky River.

TABLE 5-1

EVALUATION OF ALTERNATIVE DIRECTIONS FOR LONGWALL MINING RELATED TO NO. 9G-4 MINE

ACTIVITY	DIRECTION OF TRAVEL OF LONGWALL FACE		
	MINING TO DIP	MINING TO RISE	MINING ON STRIKE
Development	Difficult with conventional equipment over 15°	Difficult with conventional equipment over 15°	Can be readily developed with conventional equipment
Roadway Section	Rectangular configuration	Rectangular configuration	Will require trapezoidal section in inclined seams to avoid mining roof
Panel Length	Limited by syncline/anticline structure. Less than 2,400 feet	Limited by syncline/anticline structure. Less than 2,400 feet	Arbitrarily chosen at 5,000 feet
Face Changes	Frequent less than 7 months	Frequent less than 7 months	Annually
Caving	Waste may encroach into face travelling path	No problem waste falls away from face line	No problems
Coal Delivery	Poor coal flow from machine to conveyor	Good coal flow assisted by gravity	Good coal flow assisted by gravity
Water	May accumulate on the face line	No problem water will migrate to waste	No problem water will migrate to gate road
Ventilation	No problem methane will migrate to waste	May be difficult to disperse methane over return drive	Antitropal ventilation can assist methane migration
Coal Transport	Problems with conventional conveyors over 20°	Problems with conventional conveyors over 20°	No problems anticipated
Supplies Transport	Difficult in excess of 10°	Difficult in excess of 10°	No problems
Face Gradient	Horizontal	Horizontal	Inclined up to 20°
Coal Spalling	Not a problem	Coal may spall into support line: face sprags would minimize this effect	Coal may spall into support line: face sprags would minimize this effect
Grading Face Conveyor	Becomes more difficult as grade increases	Becomes more difficult as grade increases	Not a problem
Equipment Transfer	Relatively easy	Relatively easy	Relatively easy

TABLE 5-2

ARRANGEMENT OF LEVEL DEVICES AND THE PROPOSED CONTROL SEQUENCE

CONTROL SEQUENCE - NORMAL OPERATIONS

Surface	Underground
High Level	High Level
Low Level 1	Low Level 1
Low Level 2	Low Level 2
Low Level 3	
Low Level 4	

SURFACE TANK

High Level operated - stop incoming water supply pumps
Low Level 1 operated - start borehole pump
Low Level 2 operated - start incoming underground water supply pump
Low Level 3 operated - sound alarm
Low Level 4 operated - stop dust suppression water supply pump

UNDERGROUND STORAGE

High Level operated - override surface tank high level control and start pump
Low Level 1 operated - stop pump only when surface tank high level control operated
Low Level 2 operated - override surface tank low level control and stop pump

TABLE 5-3

TYPICAL PUMP SPECIFICATIONS

	Capacity G.P.M.	Head Ft	Delivery Ft	No. Required
Sludge Pump	50	150	200	9
District Pumps	150	100-600	7,200-9,000	3
Main Pumps	500	200	2,000	2

TABLE 5-4

McINTYRE MINES: SMOKY RIVER

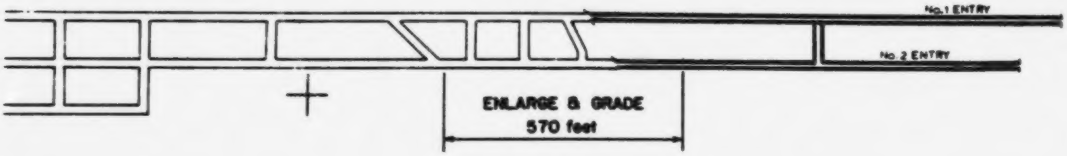
Underground Pumps

MANUFACTURER	MODEL	CAPACITY G.P.M.	HEAD FT (MAX)	H.P.	REMARKS
Mackley	STSH3	600	454	100	
Gardner Denver	PW3	33-96	975	60	Duplex Plunger
Gardner Denver	TA5	200-350	700	150	Triplex
Flygt (Bibo 3)	PK101	230	0	5.5	High head
		0	120	5.5	impeller
Flygt (Bibo 5)		600	0	48	High head
		0	240	48	impeller
Allis Chalmer	PC56A	1200		75	2 Stage

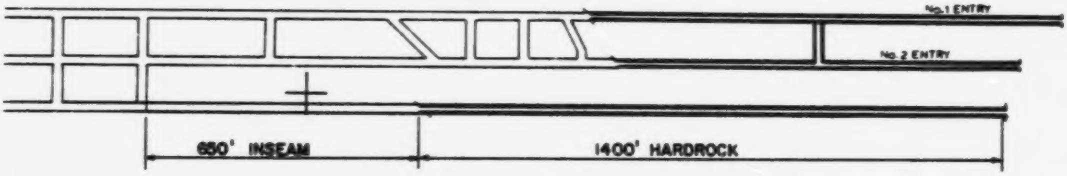
Comments

Sludge Pumps:	Flygt PK101 (Bibo 3)
District Pumps:	Gardner Denver TA5 or PW3
Main Pumps:	Mackley STSH3 or Gardner Denver TA5

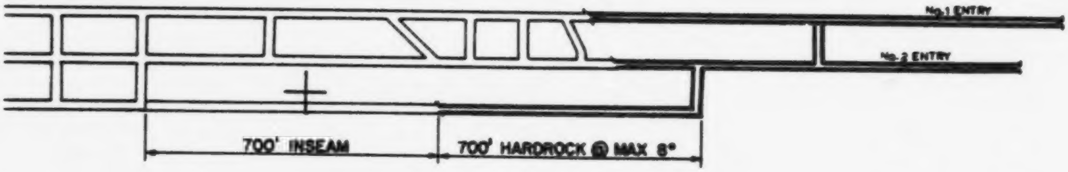
① ENLARGED ENTRY



② ADDITIONAL ENTRY



③ IN-SEAM AT 8 %

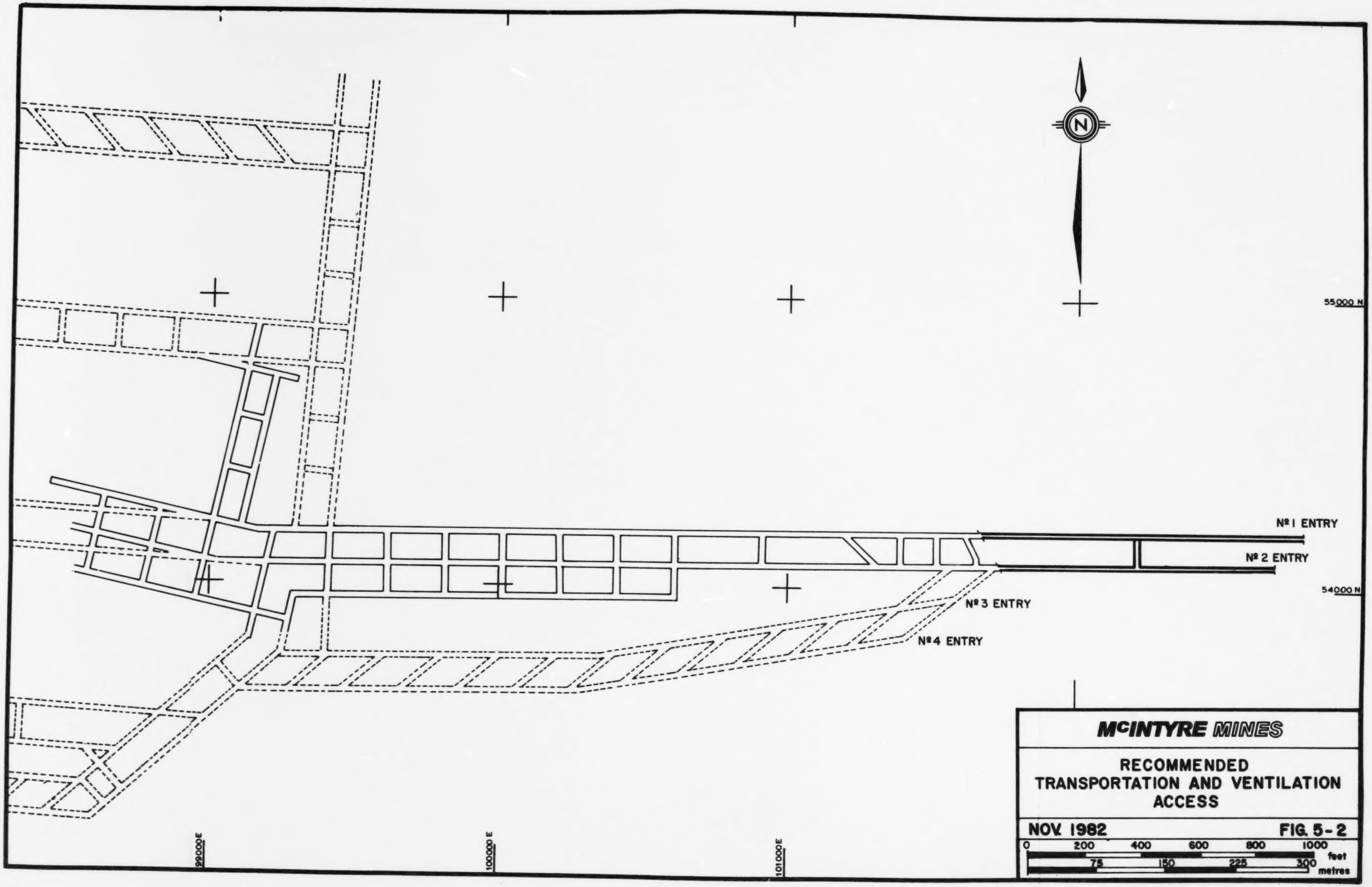


McINTYRE MINES

TRANSPORTATION AND VENTILATION
ALTERNATIVES

NOV. 1982
FIG. 5 - 1

Scale: N.T.S.

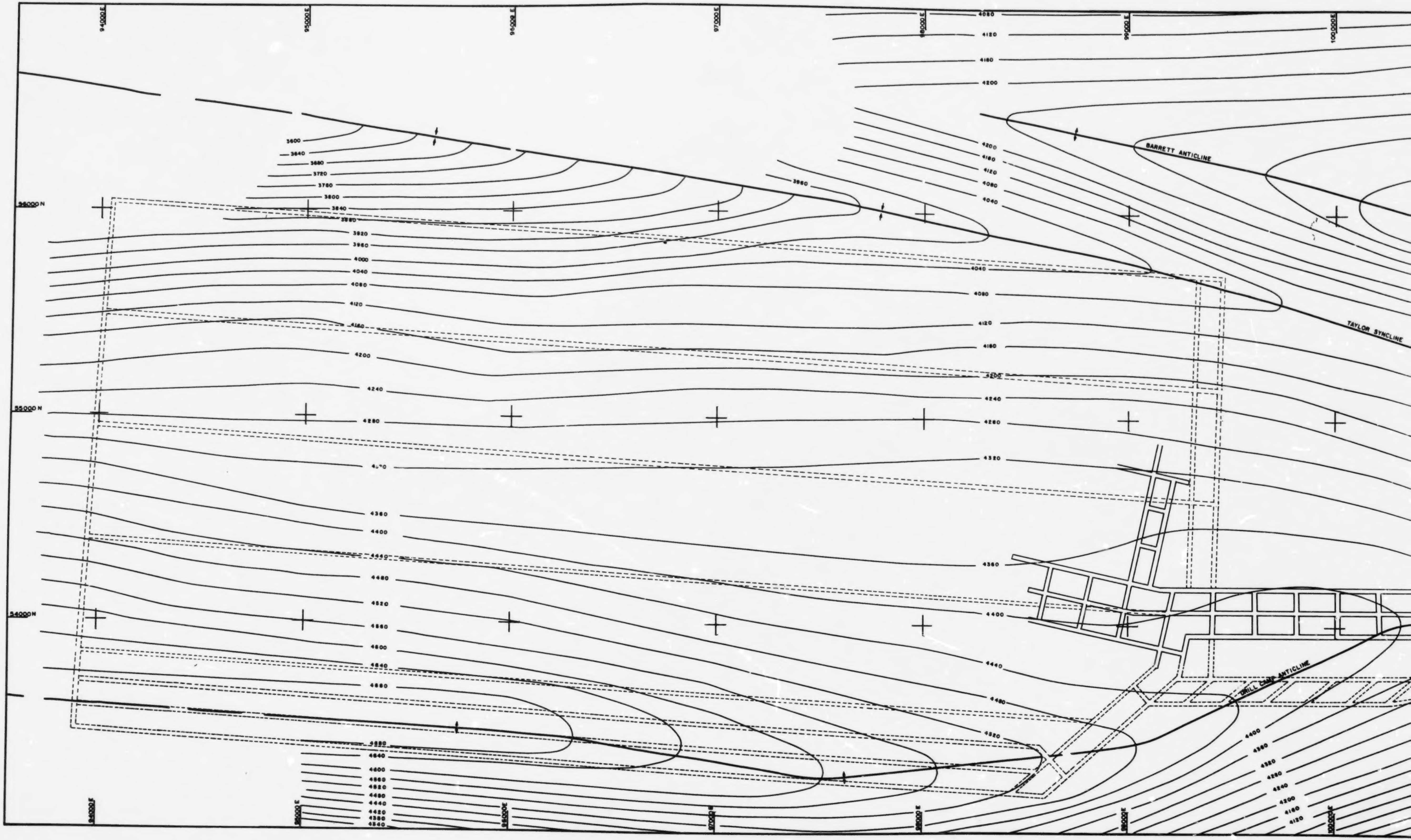


McINTYRE MINES

RECOMMENDED
TRANSPORTATION AND VENTILATION
ACCESS

NOV. 1982

FIG. 5-2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BARRETT ANTICLINE
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TAYLOR SYNCLINE
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DRILL CAMP ANTICLINE
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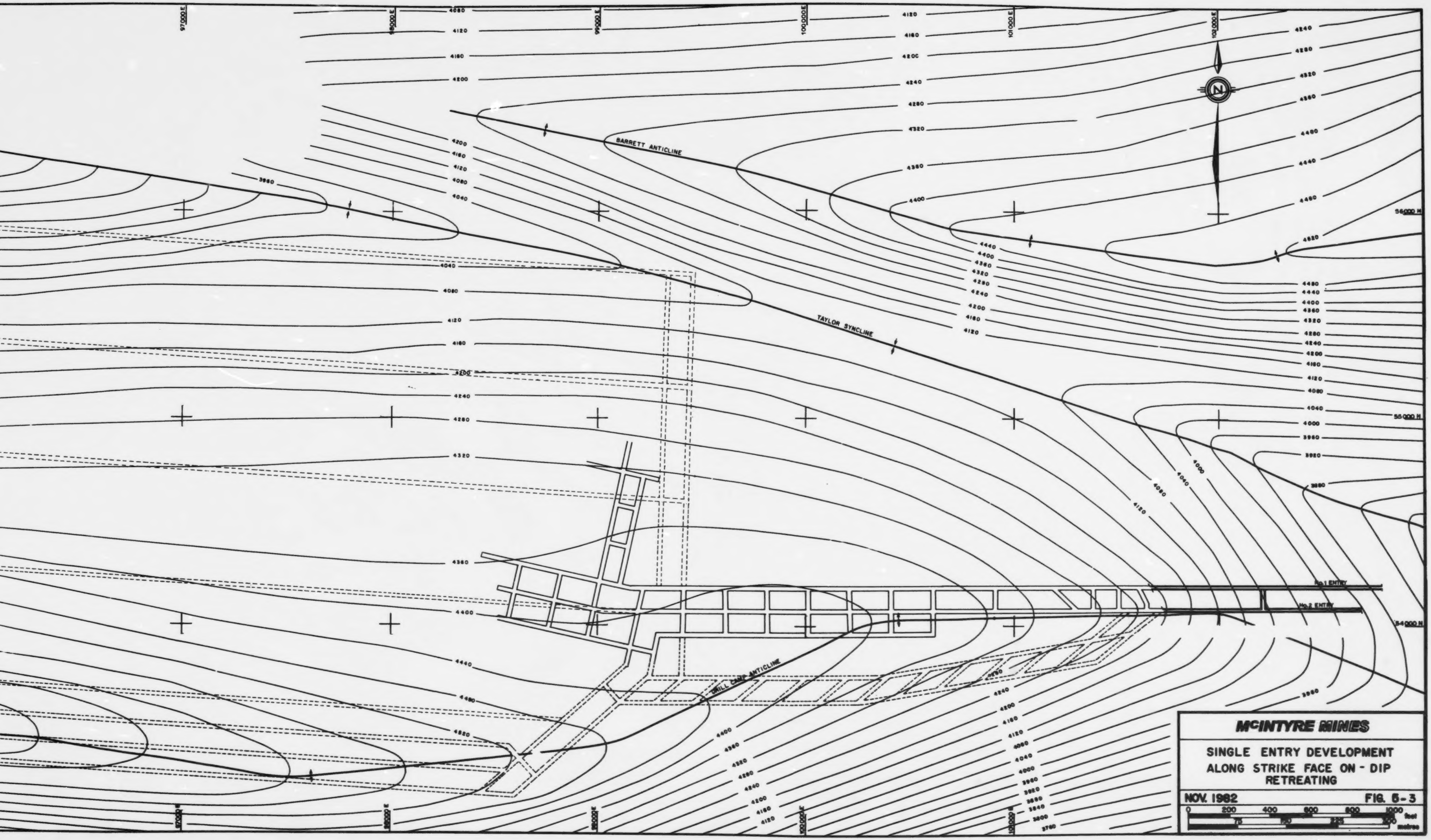
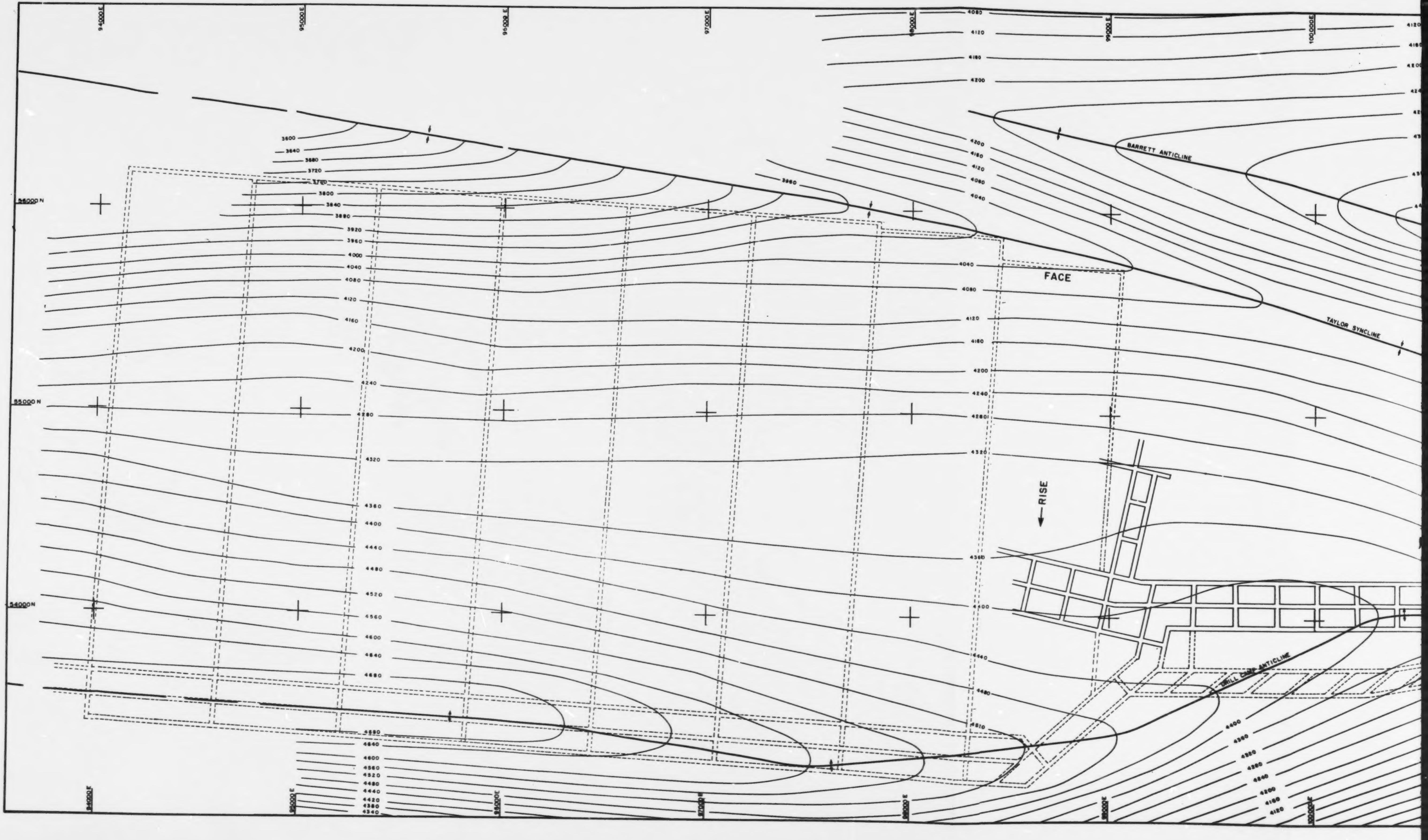


McINTYRE MINES

SINGLE ENTRY DEVELOPMENT
ALONG STRIKE FACE ON - DIP
RETREATING

NOV. 1982

FIG. 5-3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BARRETT ANTICLINE
TAYLOR SYNCLINE
DRILL CAMP ANTICLINE
FACE
RISE
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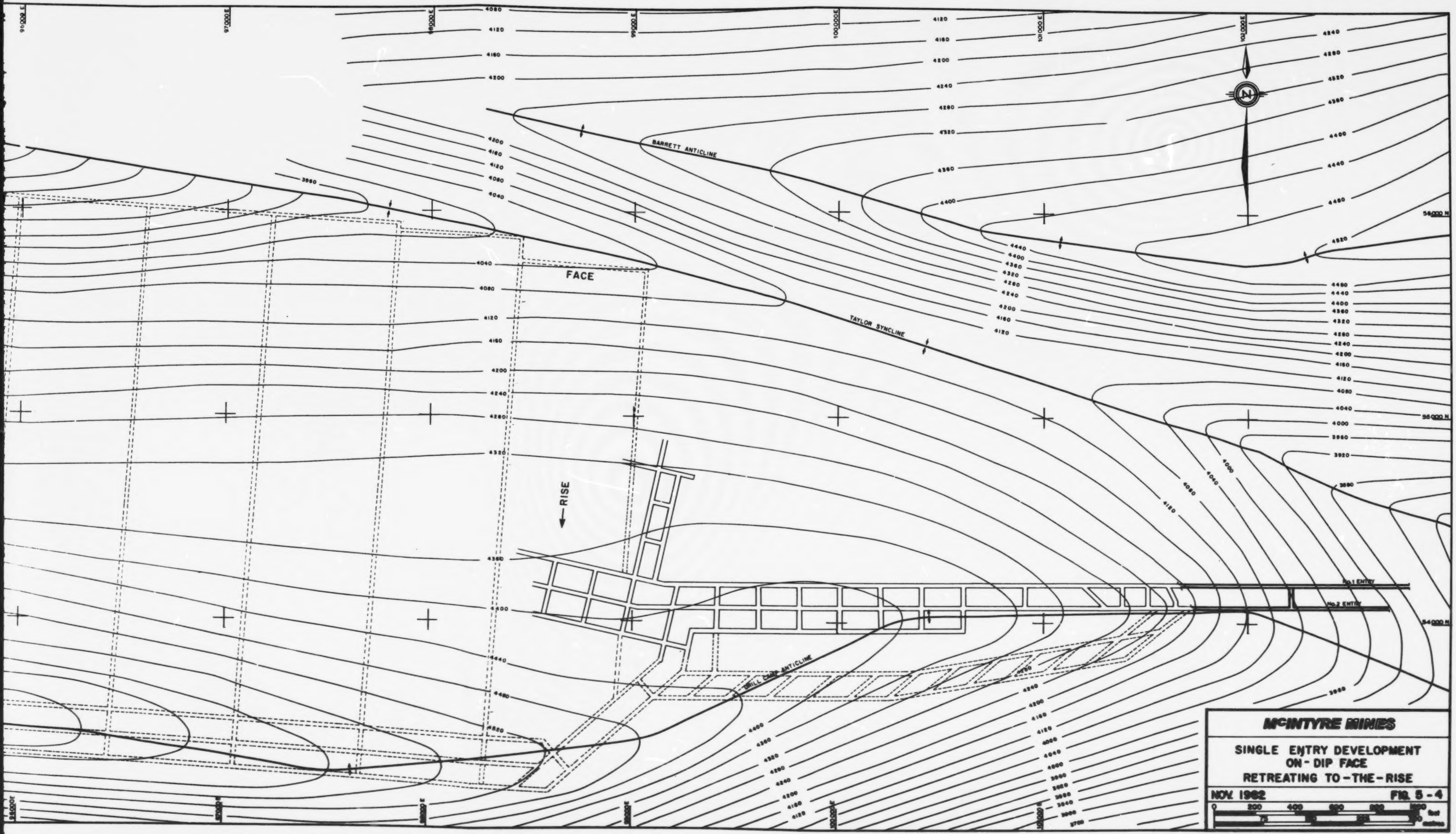
4160
4200

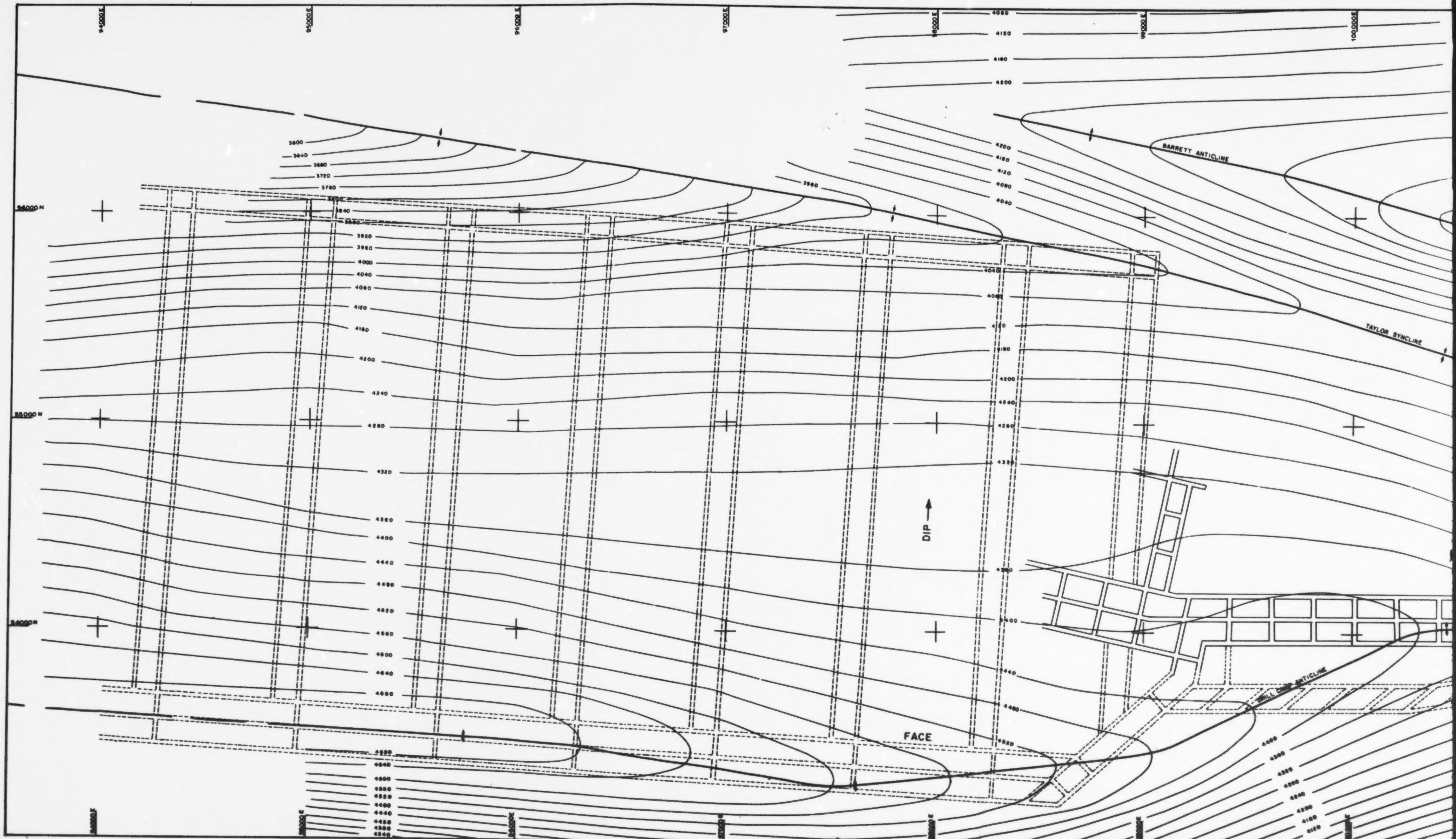


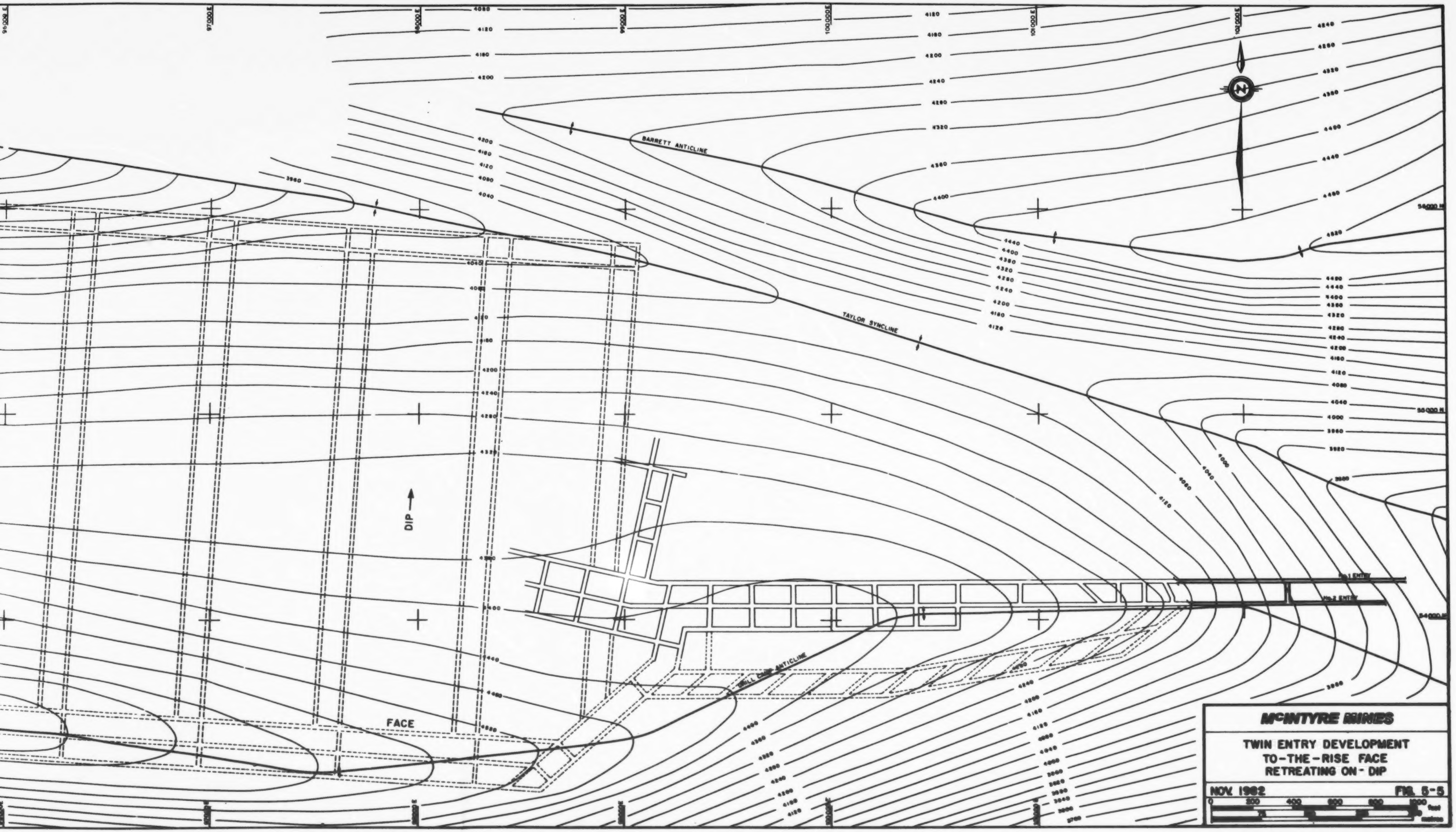
McINTYRE MINES

SINGLE ENTRY DEVELOPMENT
ON-DIP FACE
RETREATING TO-THE-RISE

NOV. 1982

FIG. 5-4


94000 E
95000 E
96000 E
97000 E
98000 E
99000 E
100000 E
36000 N
35000 N
34000 N
3600
3640
3680
3720
3760
3800
3840
3880
3920
3960
4000
4040
4080
4120
4160
4200
4240
4280
4320
4360
4400
4440
4480
4520
4560
4600
4640
4680
BARRETT ANTICLINE
TAYLOR SYNCLINE
BULL CREEK ANTICLINE
DIP
FACE

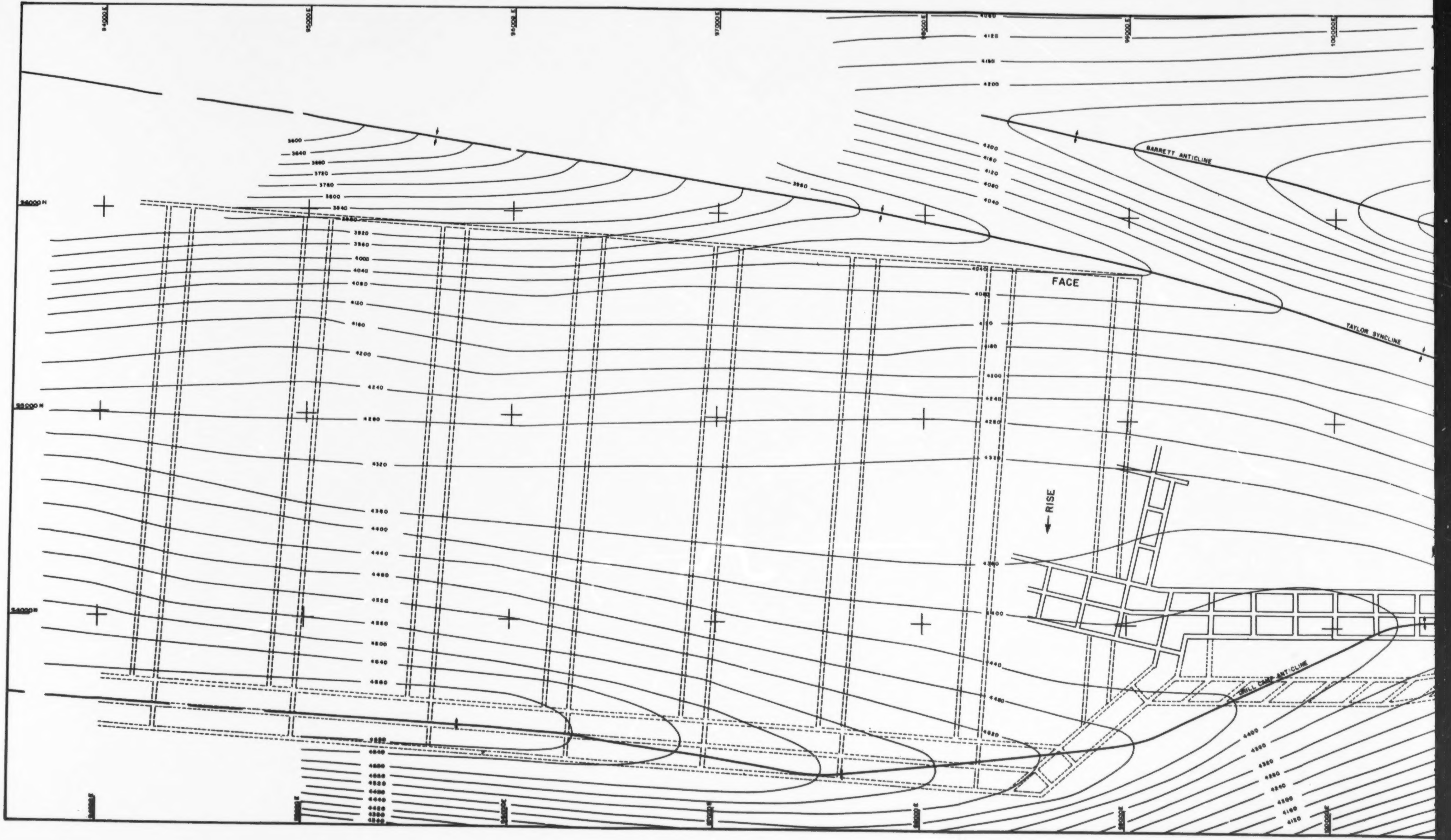


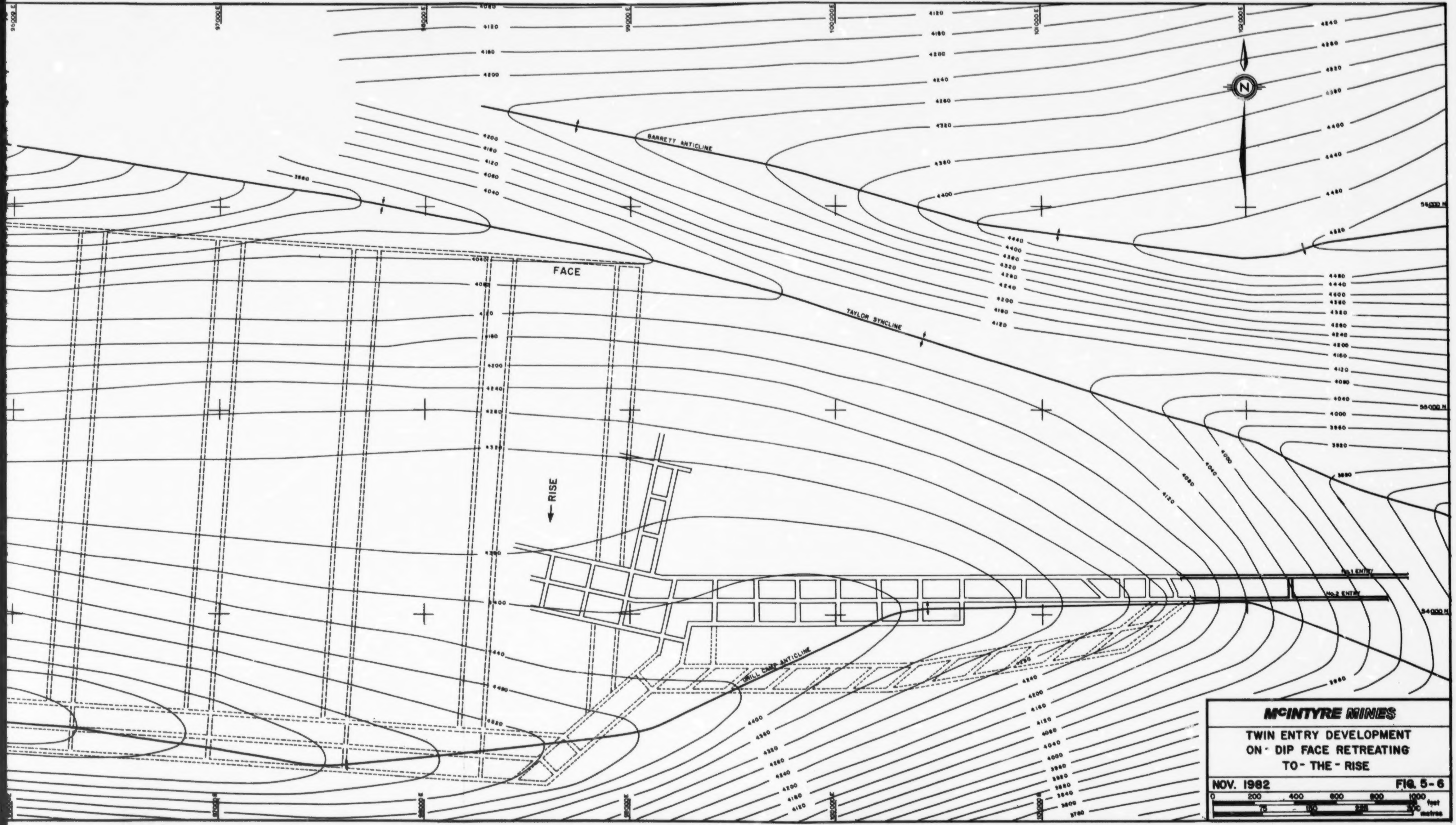
McINTYRE MINES

TWIN ENTRY DEVELOPMENT
TO-THE-RISE FACE
RETREATING ON-DIP

NOV. 1982

FIG. 5-5


94000 E
95000 E
96000 E
97000 E
98000 E
99000 E
100000 E
96000 N
95000 N
94000 N
3600
3640
3680
3720
3760
3800
3840
3880
3920
3960
4000
4040
4080
4120
4160
4200
4240
4280
4320
4360
4400
4440
4480
4520
4560
4600
4640
4680
BARRETT ANTICLINE
TAYLOR SYNCLINE
DRILL CAMP ANTICLINE
FACE
RISE

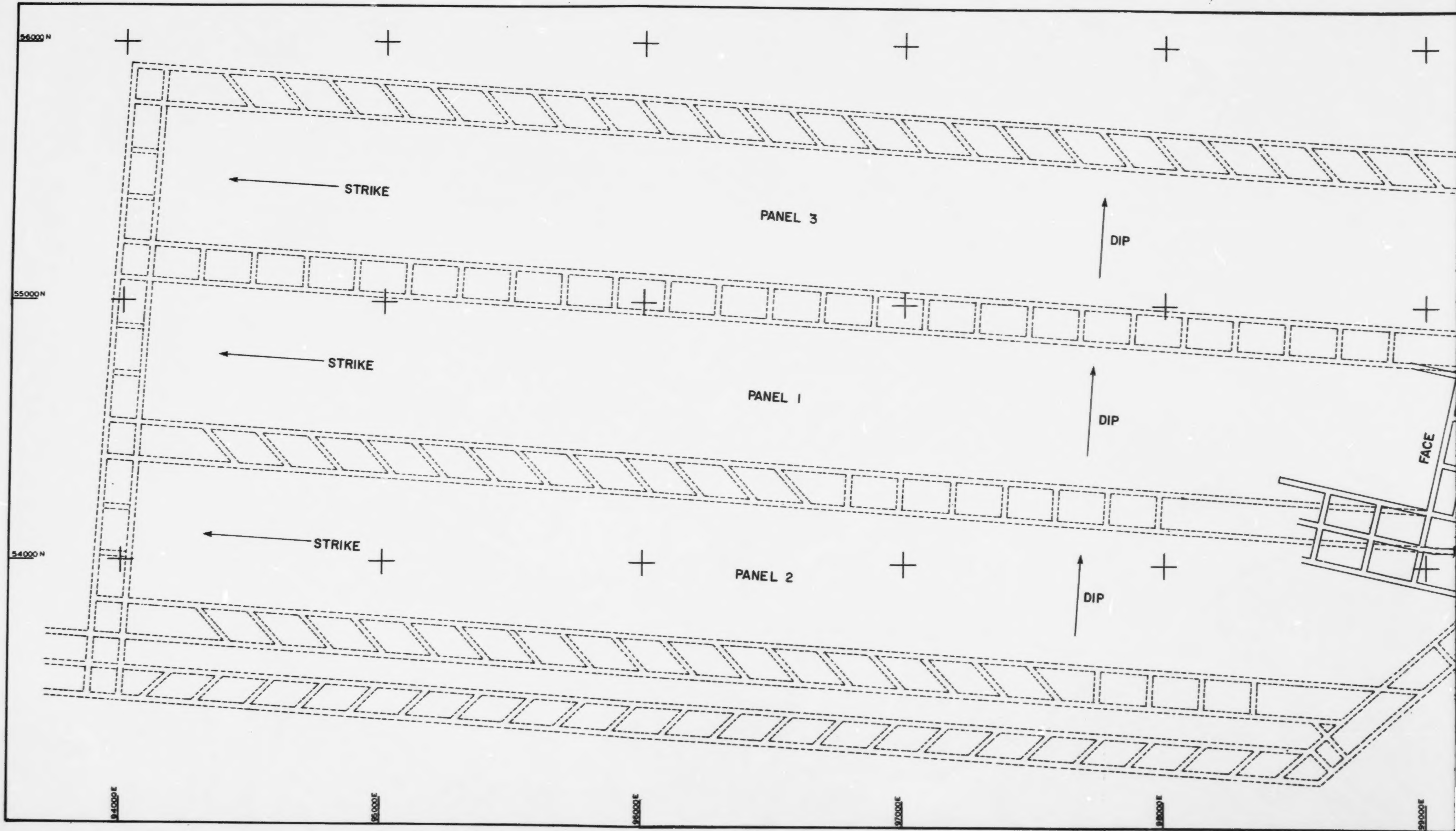


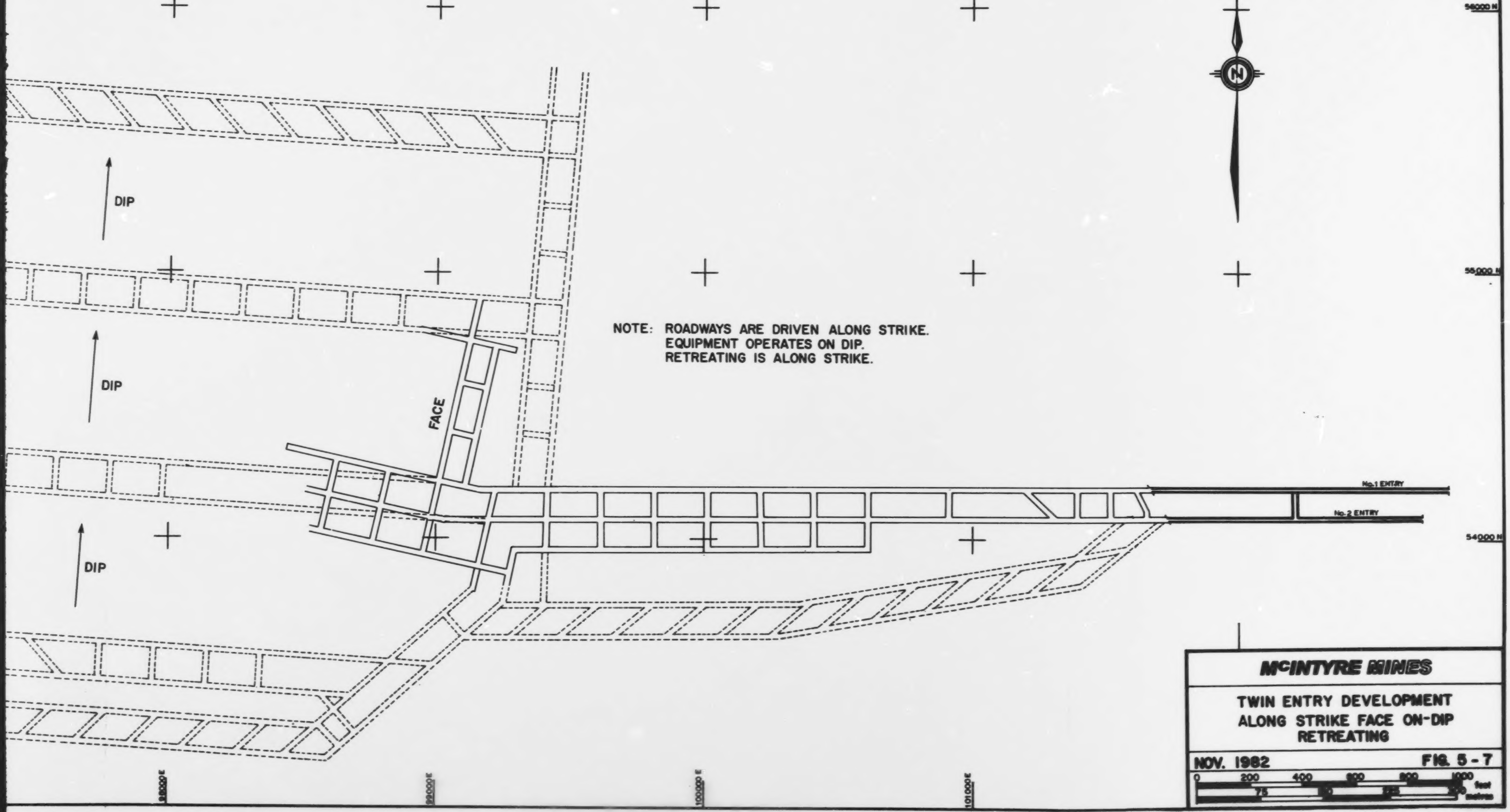
McINTYRE MINES

TWIN ENTRY DEVELOPMENT
ON - DIP FACE RETREATING
TO - THE - RISE

NOV. 1982

FIG. 5 - 6


56000 N
55000 N
54000 N
STRIKE
PANEL 3
DIP
STRIKE
PANEL 1
DIP
FACE
STRIKE
PANEL 2
DIP
94000 E
95000 E
96000 E
97000 E
98000 E
99000 E



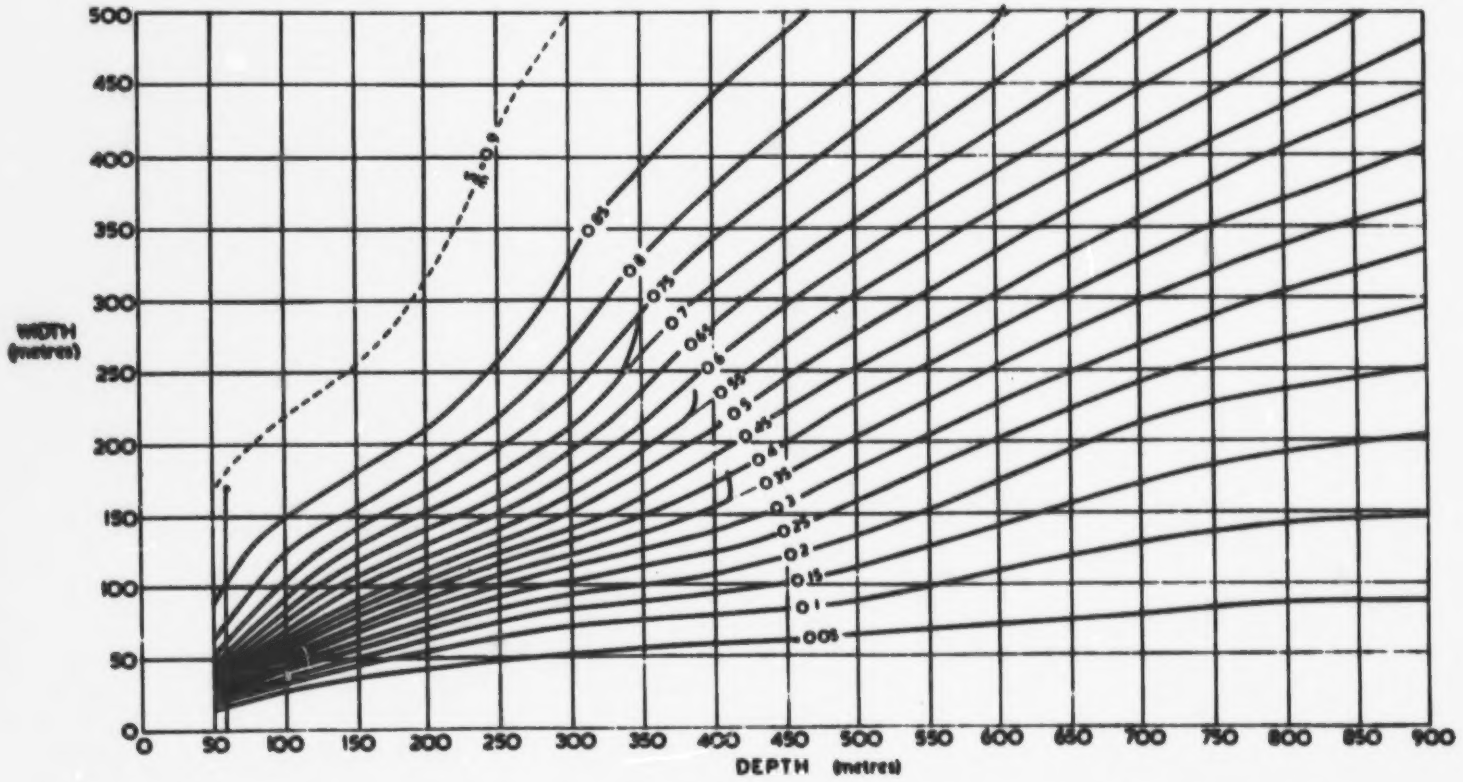
NOTE: ROADWAYS ARE DRIVEN ALONG STRIKE.
EQUIPMENT OPERATES ON DIP.
RETREATING IS ALONG STRIKE.

McINTYRE MINES

TWIN ENTRY DEVELOPMENT
ALONG STRIKE FACE ON-DIP
RETREATING

NOV. 1982

FIG. 5 - 7



Source: "SUBSIDENCE ENGINEERS HANDBOOK", N.C.B. (England), 1975.

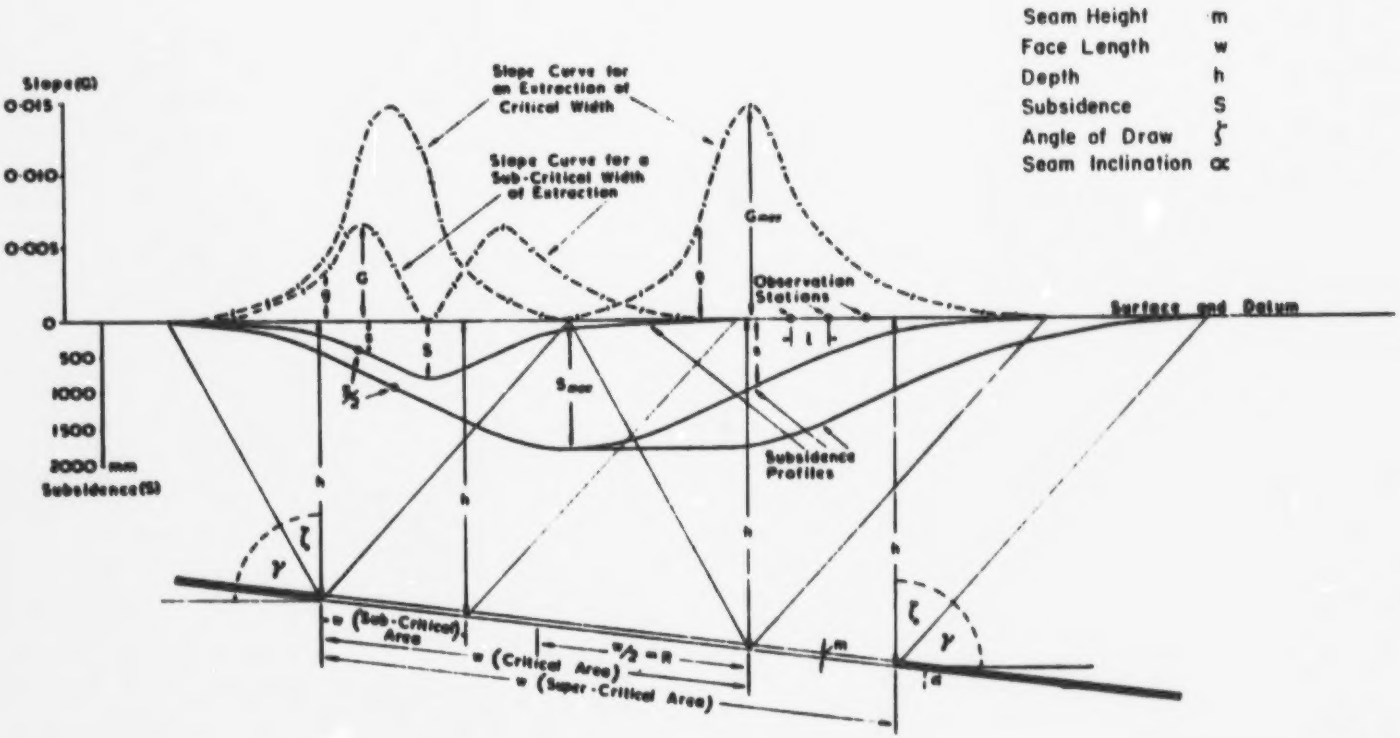
McINTYRE MINES

STANDARD PARAMETERS FOR SUBSIDENCE AND SLOPE

NOV. 1982

FIG. 5-8

Scale: N.T.S.



Source: "SUBSIDENCE ENGINEERS HANDBOOK", N.C.B. (England), 1975.

McINTYRE MINES

RELATIONSHIP OF SUBSIDENCE TO WIDTH AND DEPTH

NOV. 1982

FIG. 5-9

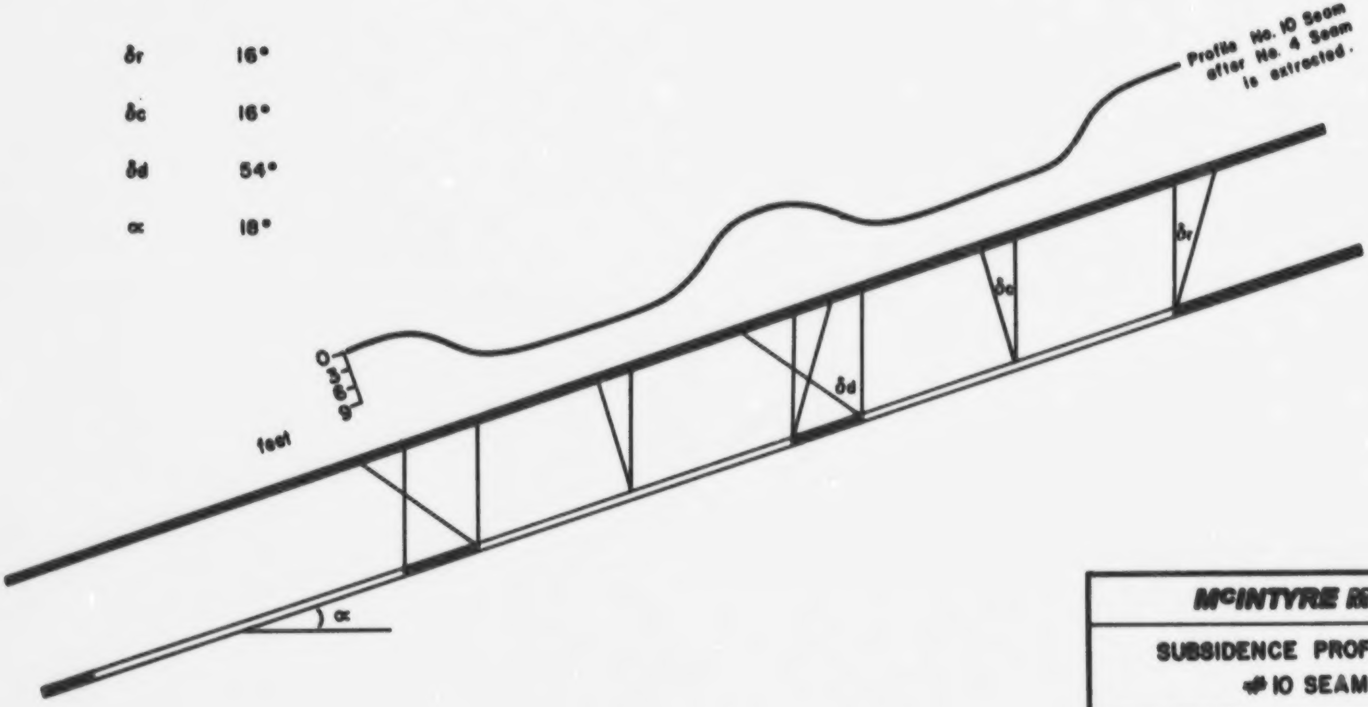
Scale: N.T.S.

SUBSIDENCE SEAM TO SEAM (basis Subsidence Engineers Handbook 1975 N.C.B.)

Face Width	550 feet	w
Seam Extraction	10 feet	m
Interval	200 feet	h

w/h = 550 ÷ 200 = 2.75
S max. = 0.9 x 10 = 9 feet

δr	16°
δc	16°
δd	54°
α	18°



McINTYRE MINES

SUBSIDENCE PROFILE FOR
#10 SEAM

NOV. 1982

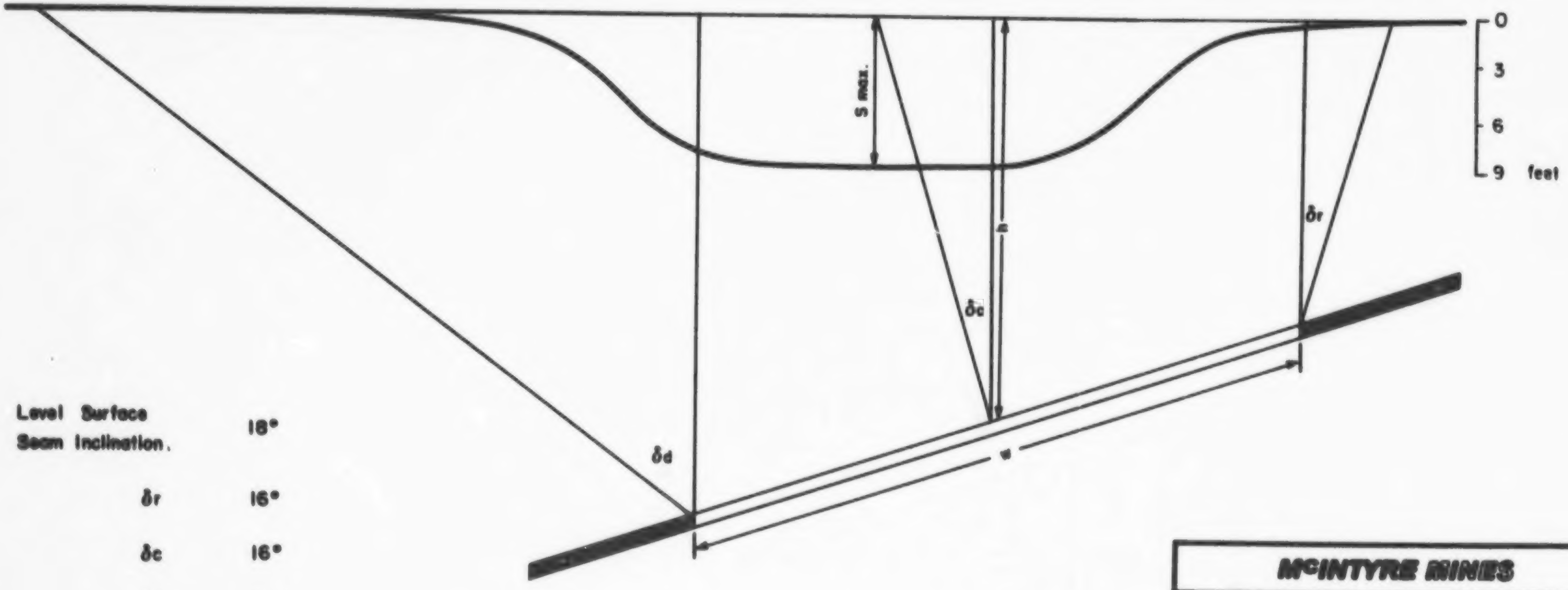
FIG. 5-10

Scale: N.T.S.

POTENTIAL SURFACE EFFECT AT 1,200' AVERAGE DEPTH

Extracted Width	550	feet	w
Seam Extraction	10	feet	m
Depth of Cover	1200	feet	h

w/h = 550 ÷ 1200 = 0.40
S max. = 0.9 x m = 9 feet
S max. maximum subsidence
S subsidence



Level Surface Seam Inclination.	18°
δr	16°
δc	16°
δd	54°

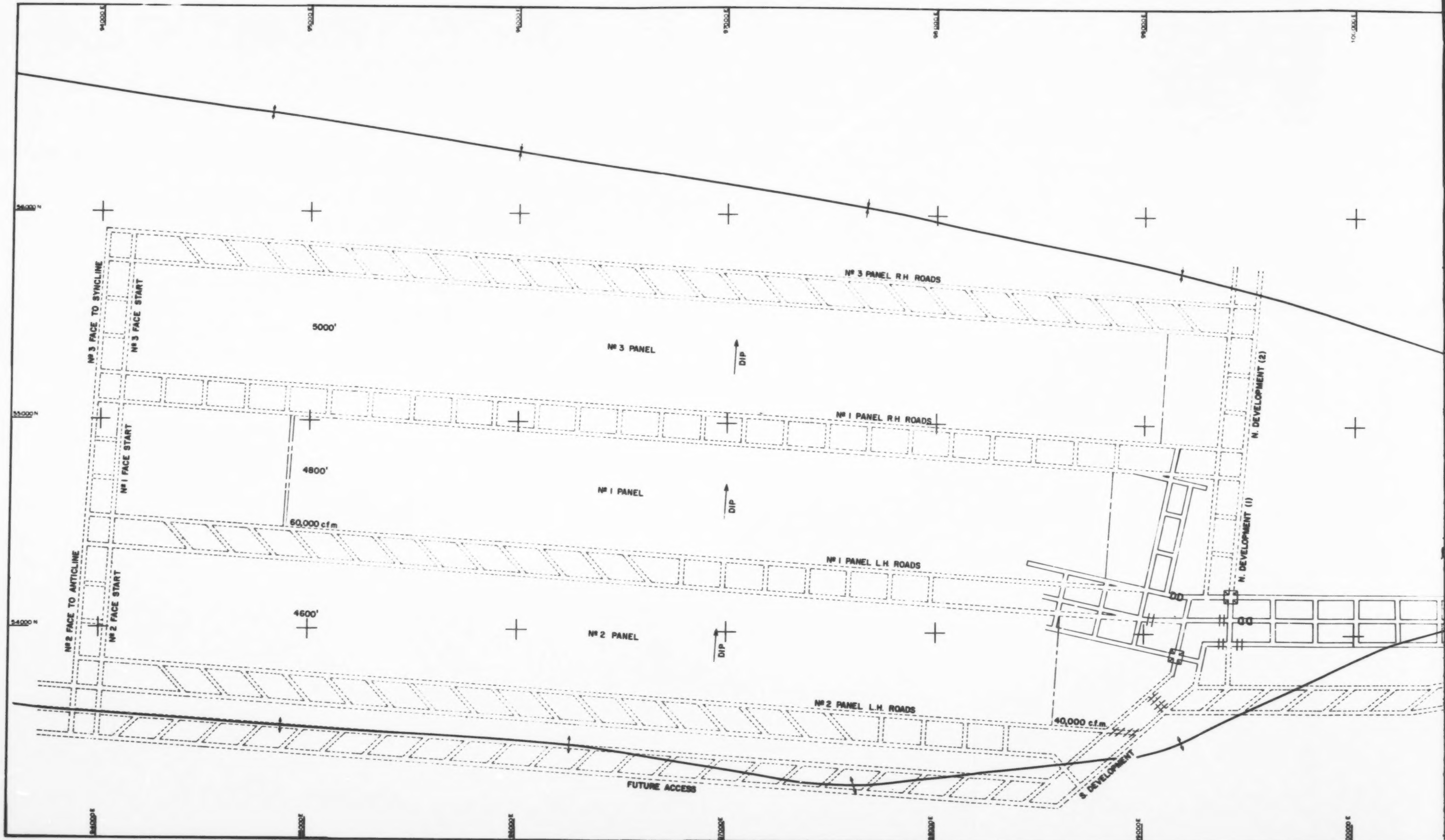
McINTYRE MINES

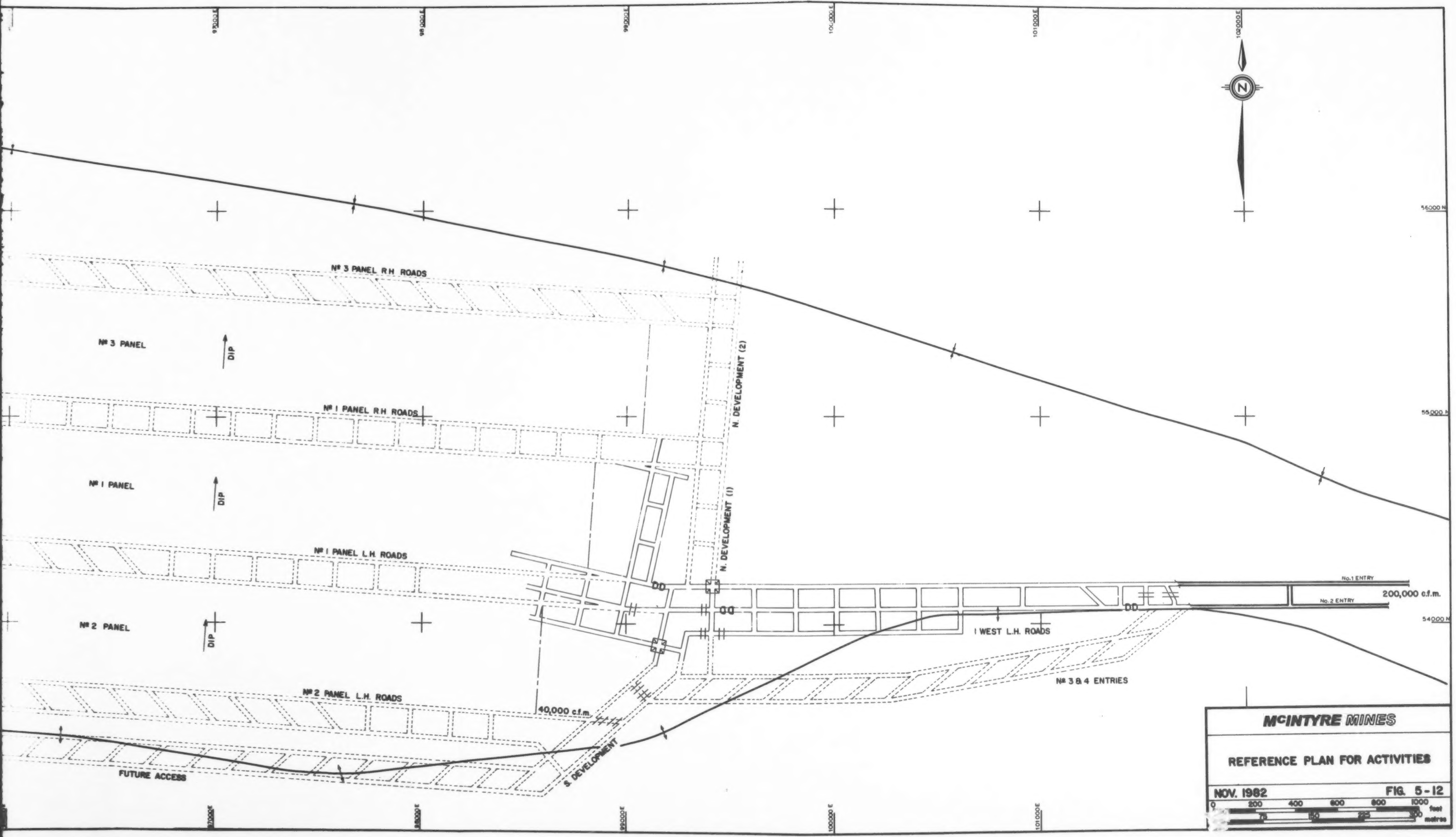
POTENTIAL SURFACE EFFECT

NOV. 1982

FIG. 5-11

Scale: N.T.S.


94000 E
95000 E
96000 E
97000 E
98000 E
99000 E
100000 E
56000 N
55000 N
54000 N
Nº 3 PANEL R.H. ROADS
Nº 3 FACE TO SYNCLINE
Nº 3 FACE START
5000'
Nº 3 PANEL
DIP
Nº 1 PANEL R.H. ROADS
N. DEVELOPMENT (2)
Nº 1 FACE START
4800'
Nº 1 PANEL
DIP
60,000 c.f.m.
N. DEVELOPMENT (1)
Nº 1 PANEL L.H. ROADS
Nº 2 FACE TO ANTICLINE
Nº 2 FACE START
4600'
Nº 2 PANEL
DIP
Nº 2 PANEL L.H. ROADS
40,000 c.f.m.
FUTURE ACCESS
S. DEVELOPMENT

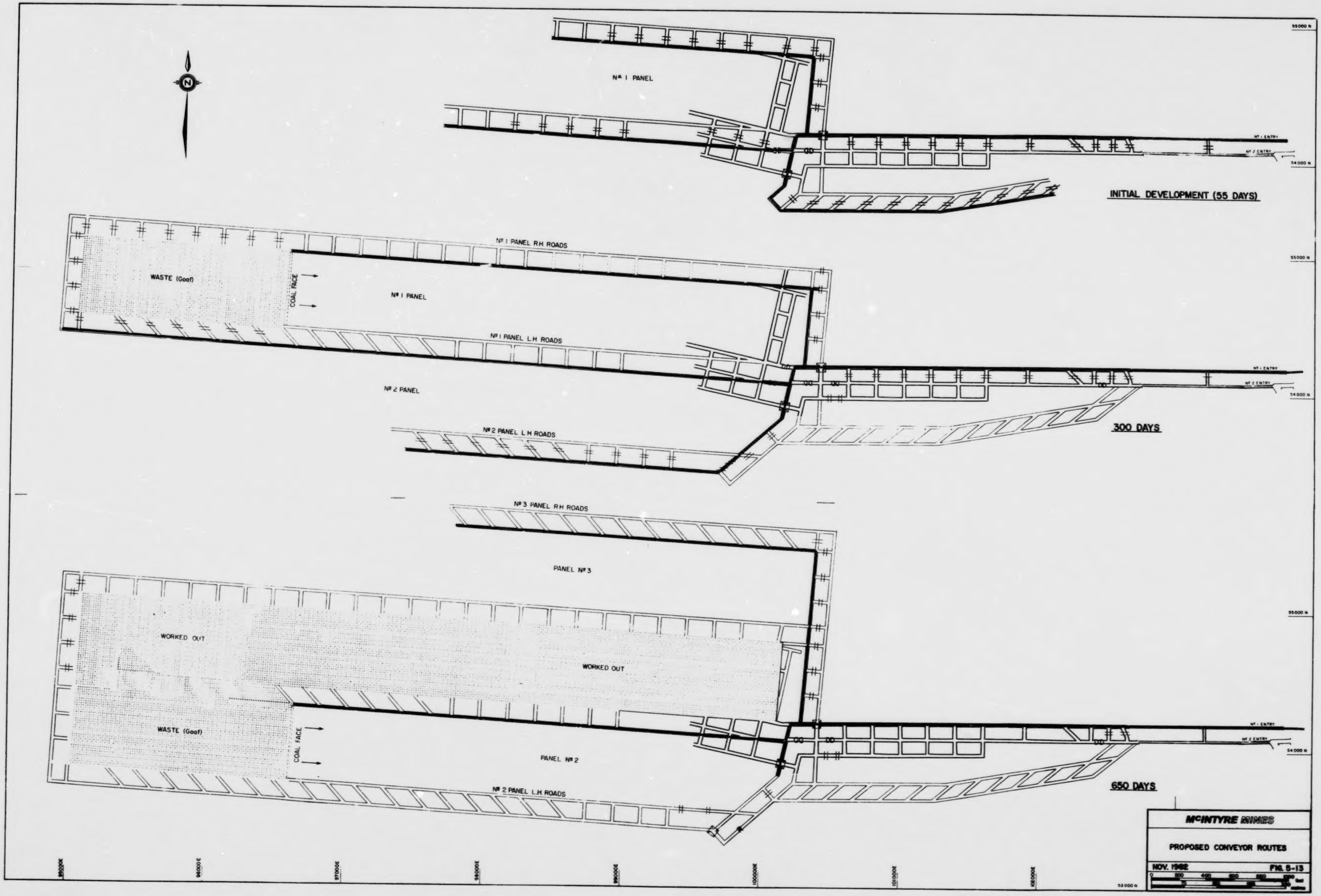


McINTYRE MINES

REFERENCE PLAN FOR ACTIVITIES

NOV. 1982

FIG. 5-12

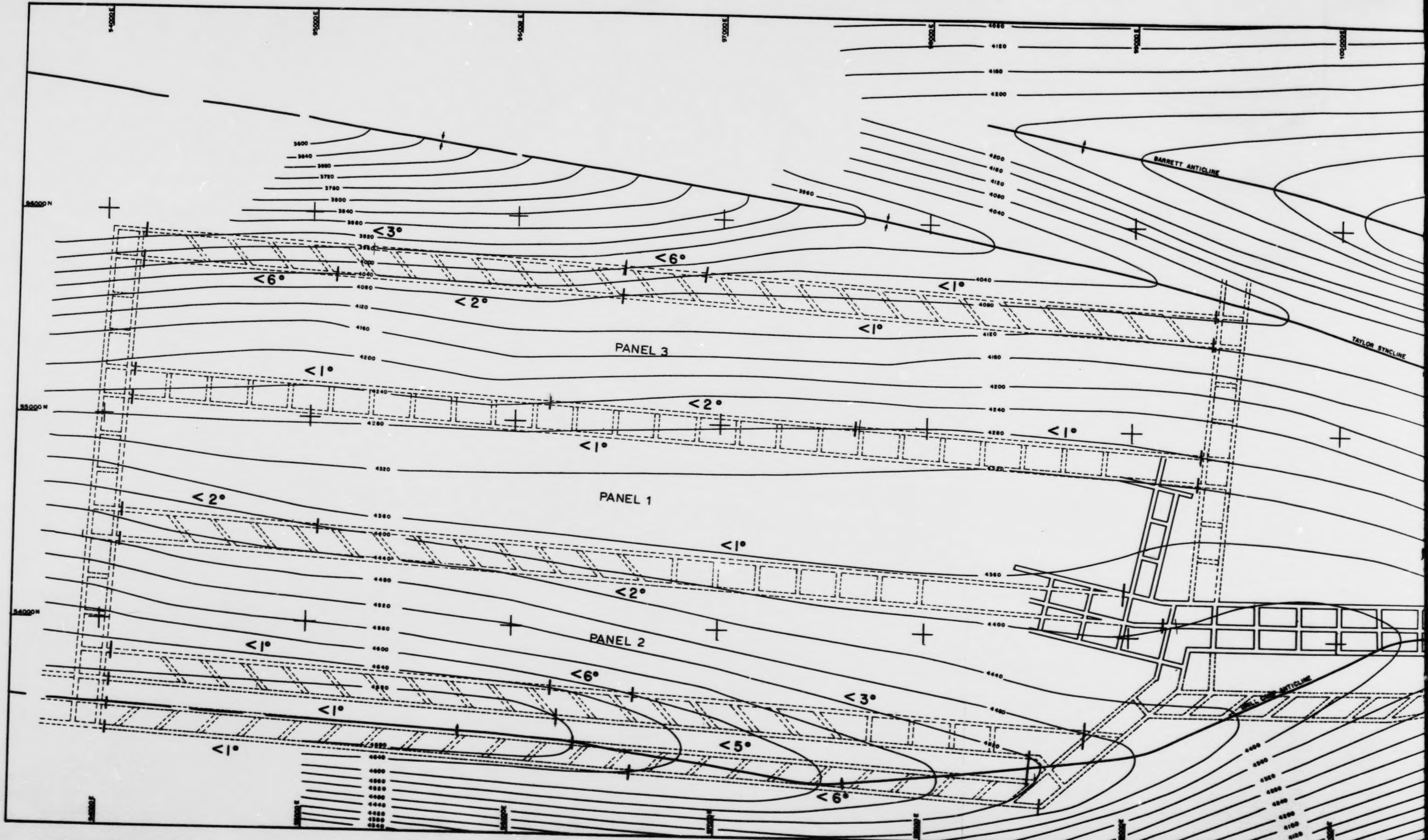


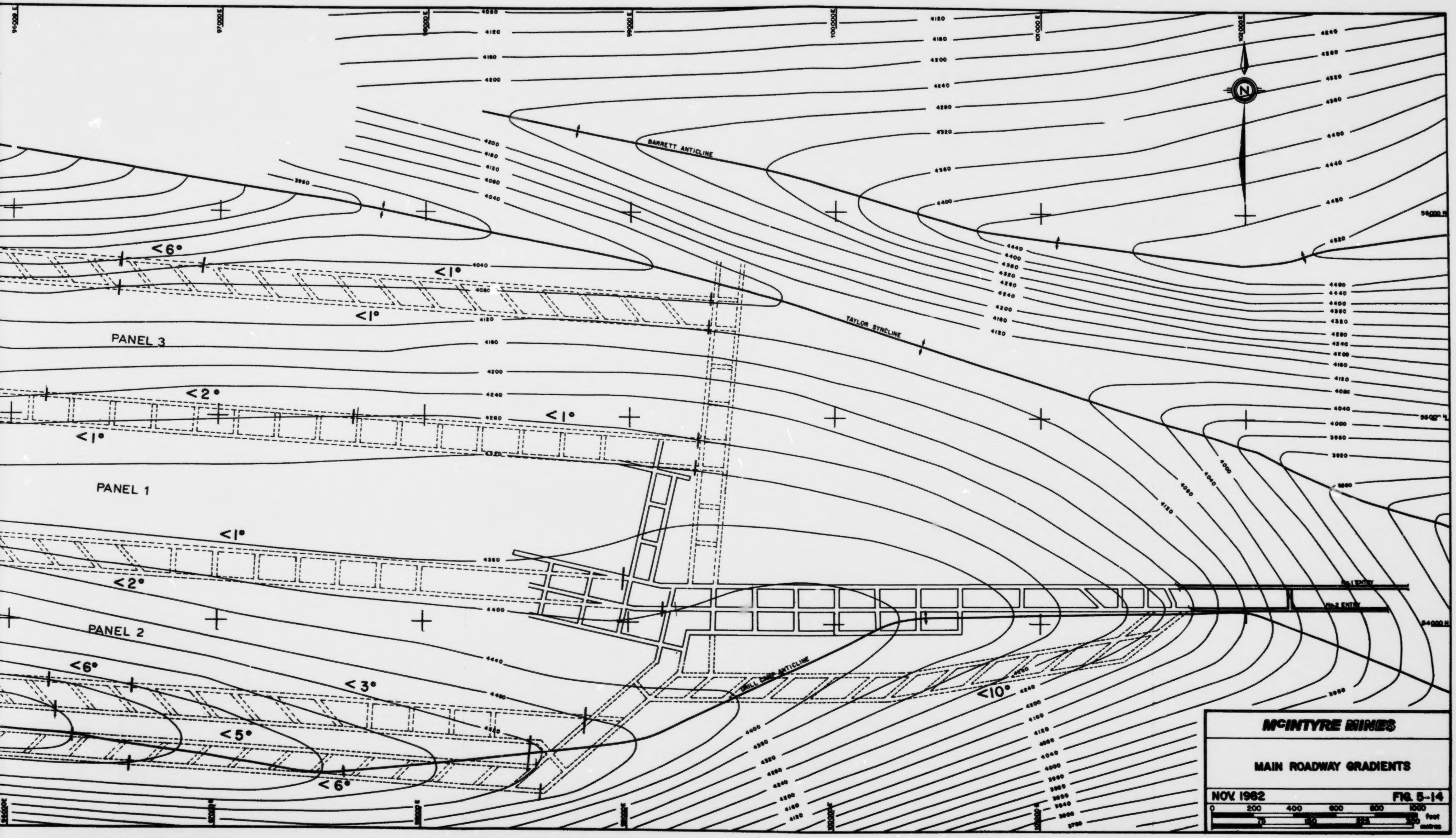
McINTYRE MINES

PROPOSED CONVEYOR ROUTES

NOV. 1982

FIG. 5-13


94000 E
95000 E
96000 E
97000 E
98000 E
99000 E
100000 E
56000 N
55000 N
54000 N
3600
3640
3680
3720
3760
3800
3840
3880
3920
3960
4000
4040
4080
4120
4160
4200
4240
4280
4320
4360
4400
4440
4480
4520
4560
4600
4640
4680
< 3°
< 6°
< 6°
< 2°
< 1°
< 1°
PANEL 3
< 1°
< 2°
< 1°
< 1°
< 2°
PANEL 1
< 1°
< 2°
PANEL 2
< 1°
< 6°
< 1°
< 3°
< 1°
< 5°
< 6°
BARRETT ANTICLINE
TAYLOR SYNCLINE
BELL CREEK ANTICLINE

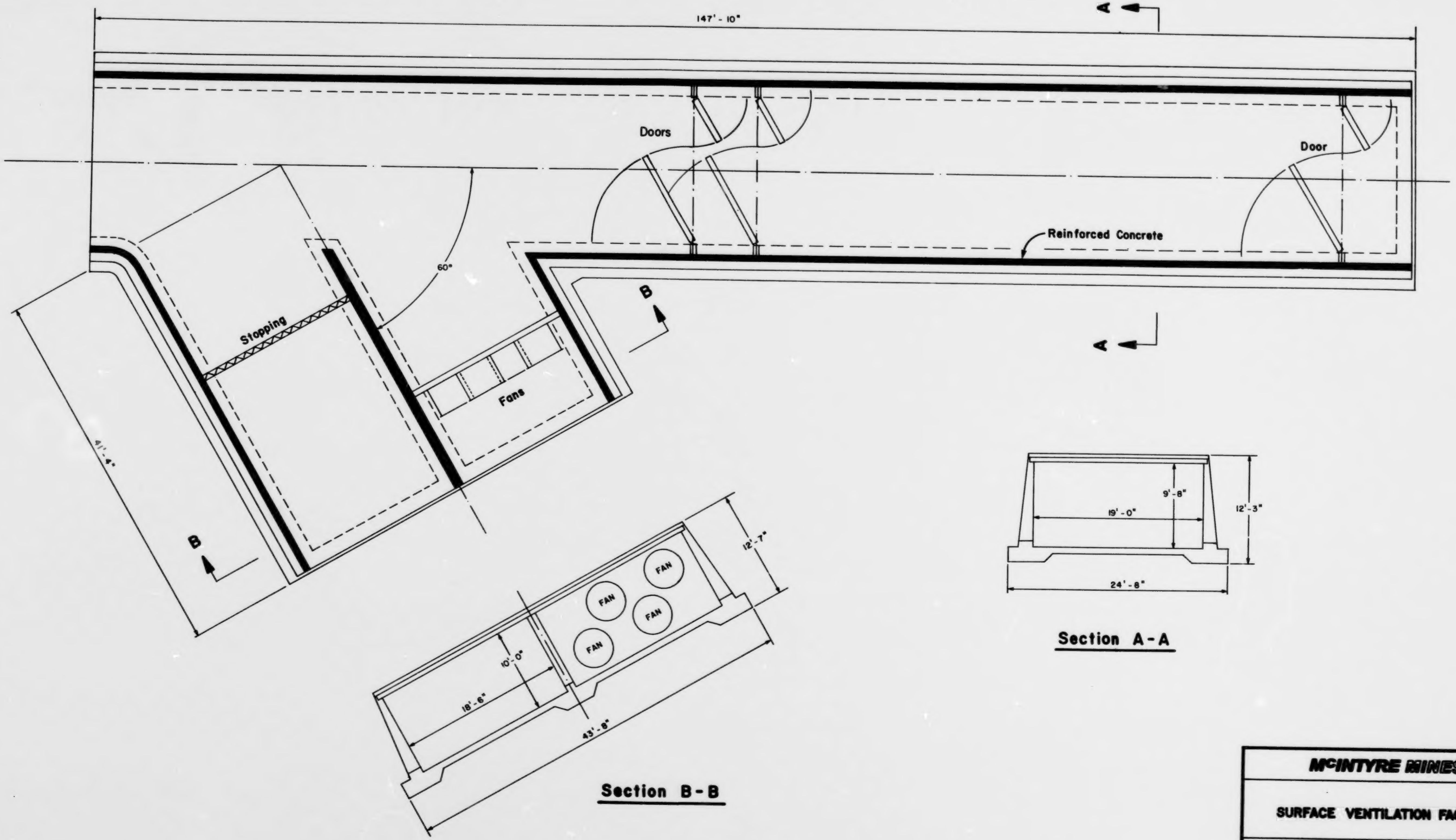


McINTYRE MINES

MAIN ROADWAY GRADIENTS

NOV. 1982

FIG. 5-14



Section A-A

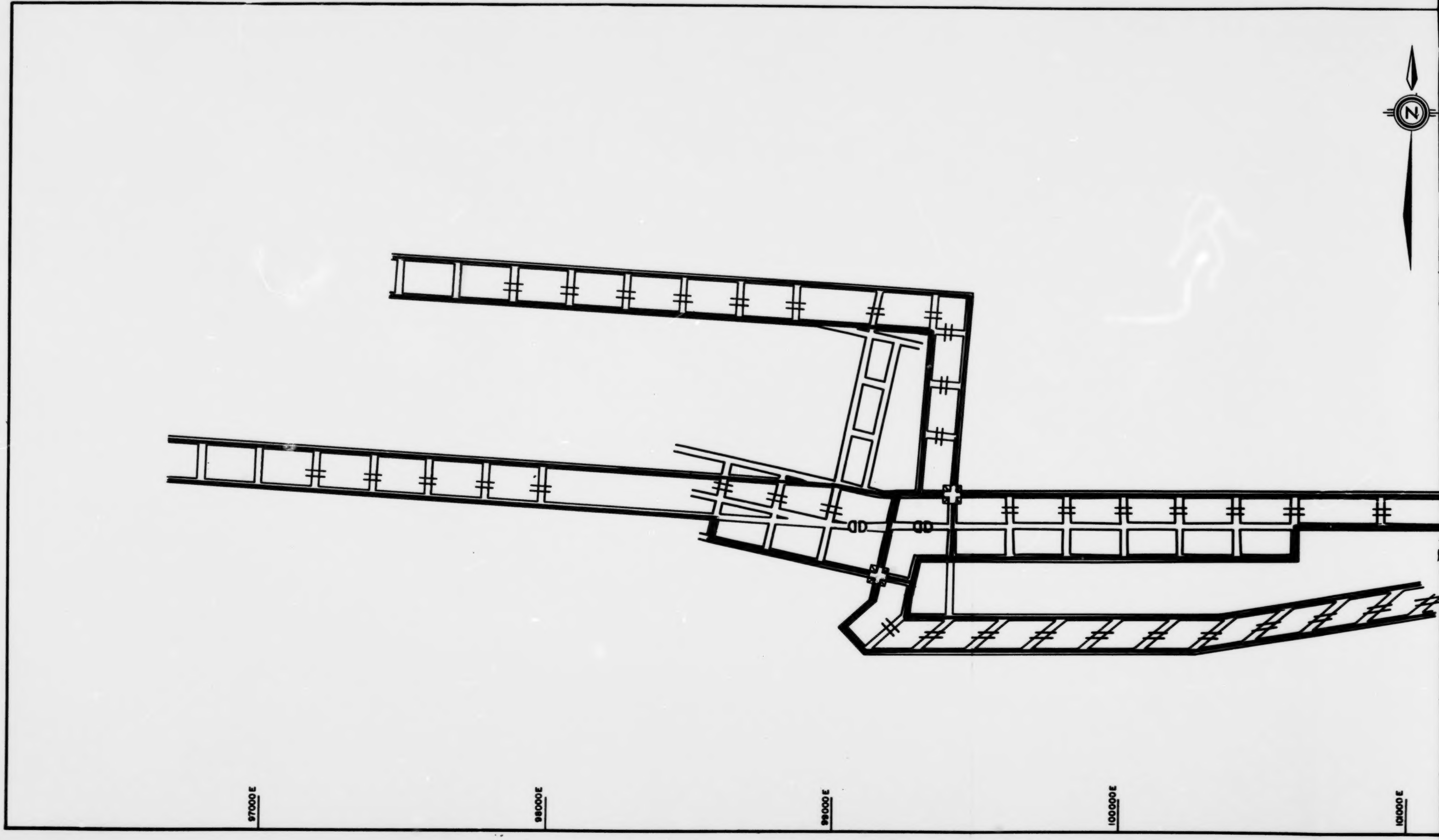
Section B-B

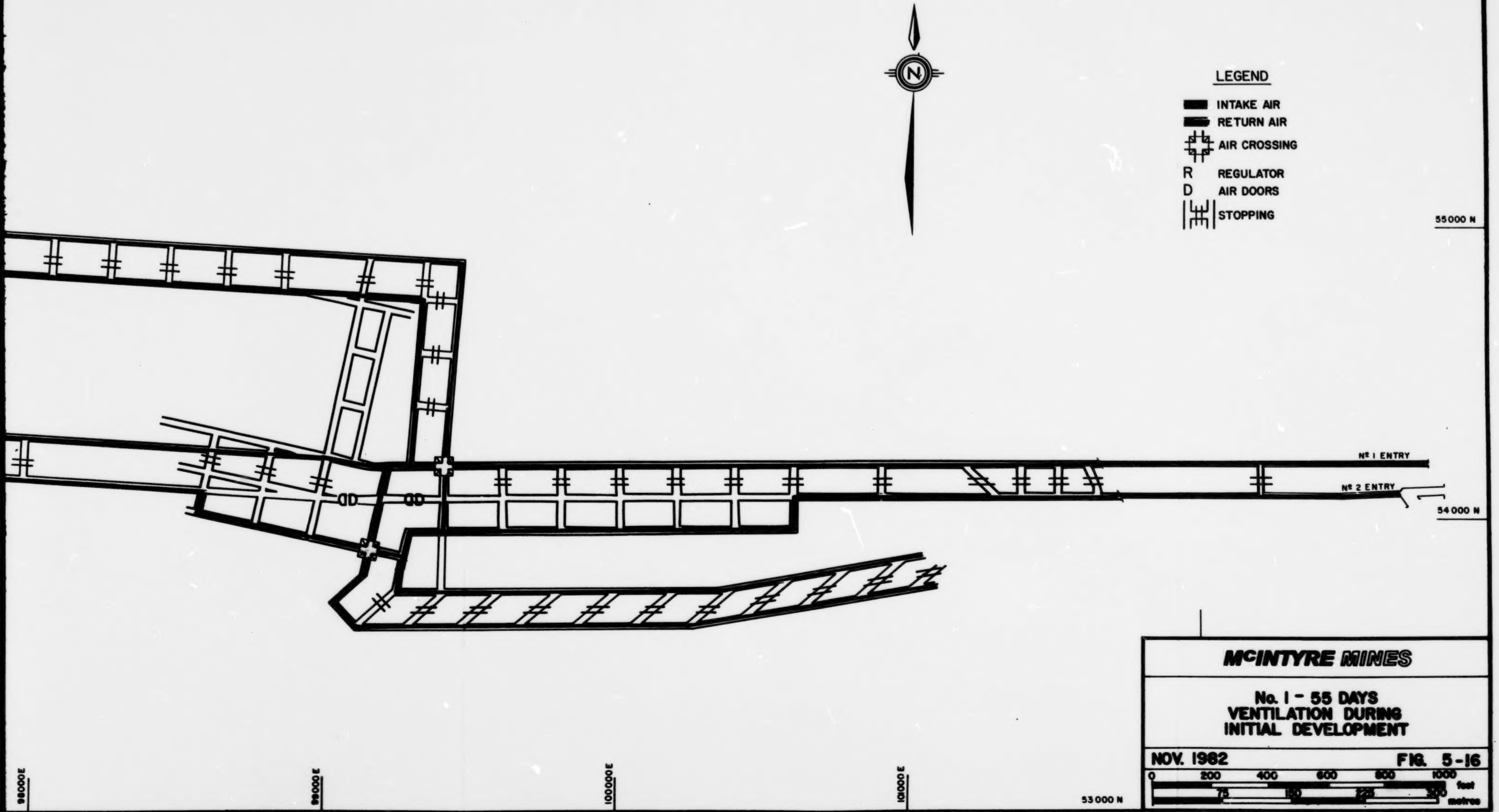
McINTYRE MINES

SURFACE VENTILATION FACILITY

NOV. 1982 FIG. 5-15

Scale: N.T.S.


N
97000 E
98000 E
99000 E
100000 E
101000 E

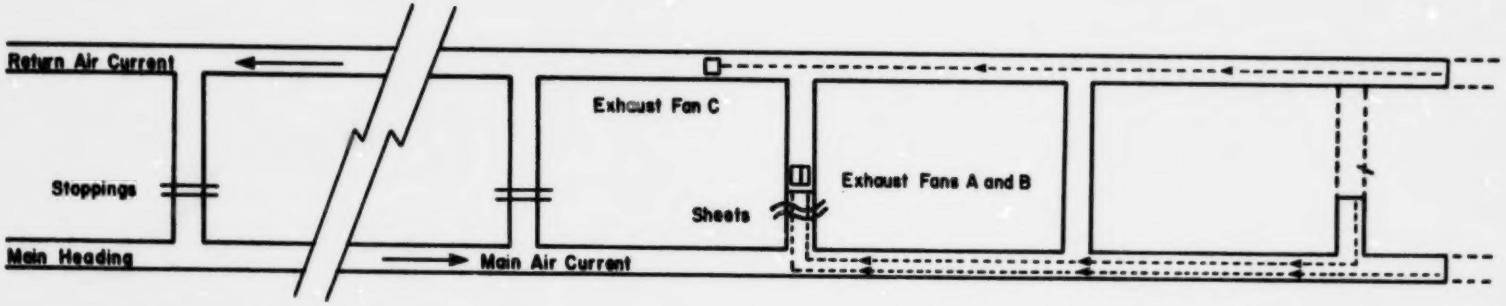


McINTYRE MINES

No. 1 - 55 DAYS
VENTILATION DURING
INITIAL DEVELOPMENT

NOV. 1982

FIG. 5-16



GENERAL INFORMATION

Pillar Sizes: 120'x 180'
Roadway Sizes (average): 16'x 10'
Air Velocity in Heading: 70'/minute
Air Quantity Required: 11,200 cfm/heading
No. of Headings: 3
Air Quantity for Headings: 33,600 cfm
Air Quantity Inbye Fans: 40,000 cfm

AUXILIARY EXHAUST FANS

Make: Engart
Type: B70
H.P.: 50 (37 kW)
Diameter: 36"
Number Required: 8 (for two developments initially)

VENTILATION DUCTING

Type: Flexaduct
Diameter: 36"
Bends (90°): 6

NOTES

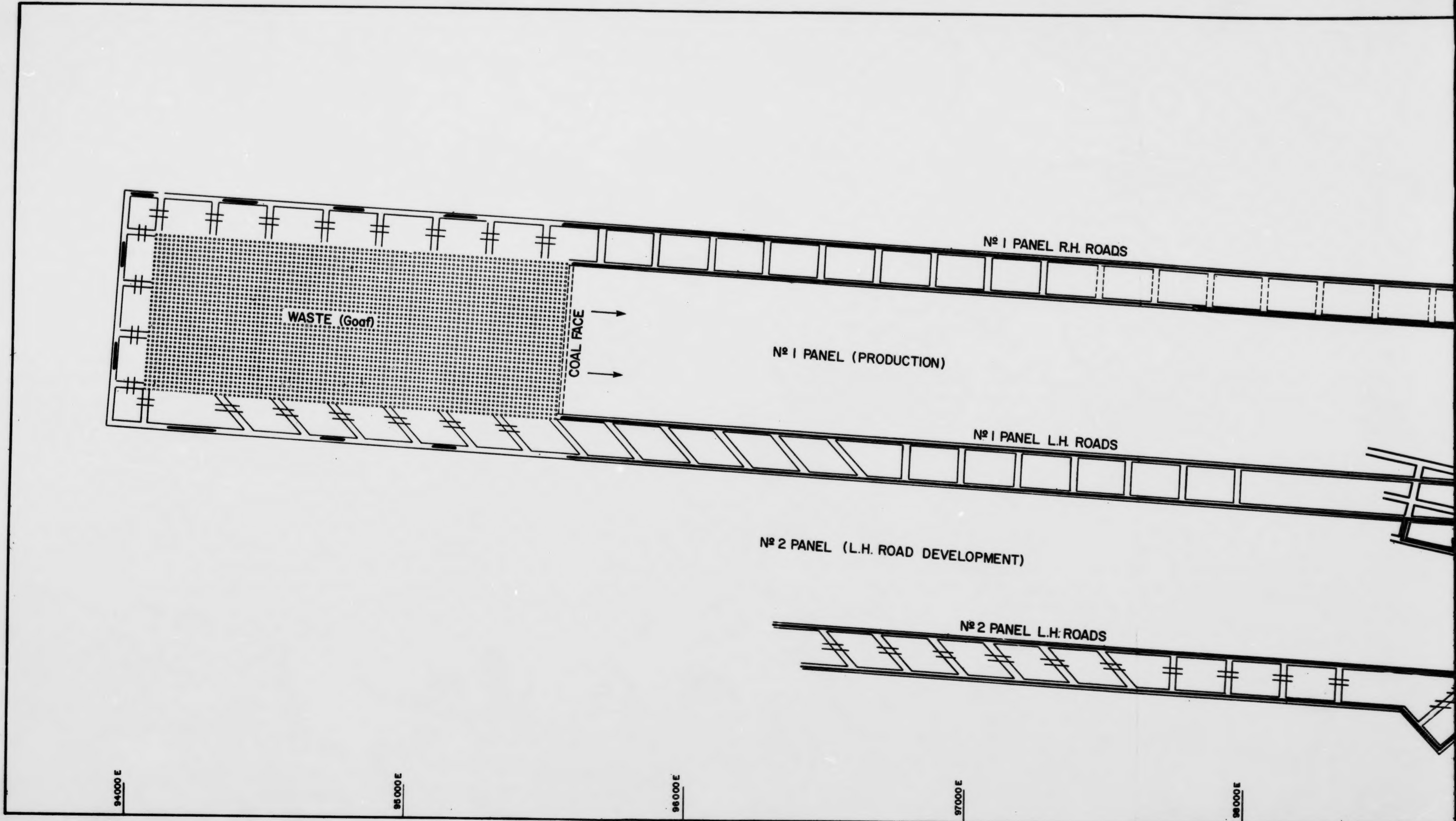
1. The planned development rates and ventilation quantities give general body values of methane at 0.4%.
2. If methane layering occurs, it will be locally dispersed either by a forced ventilation air mover or hurdle cloth.
3. Exhaust ventilation will remove respirable dust from the development team in the heading.
4. The air required at the fan crosscut for two developments is 80,000 cfm.
5. The fans may be located in the inbye crosscut so reducing the length of the ventilation tubing required.

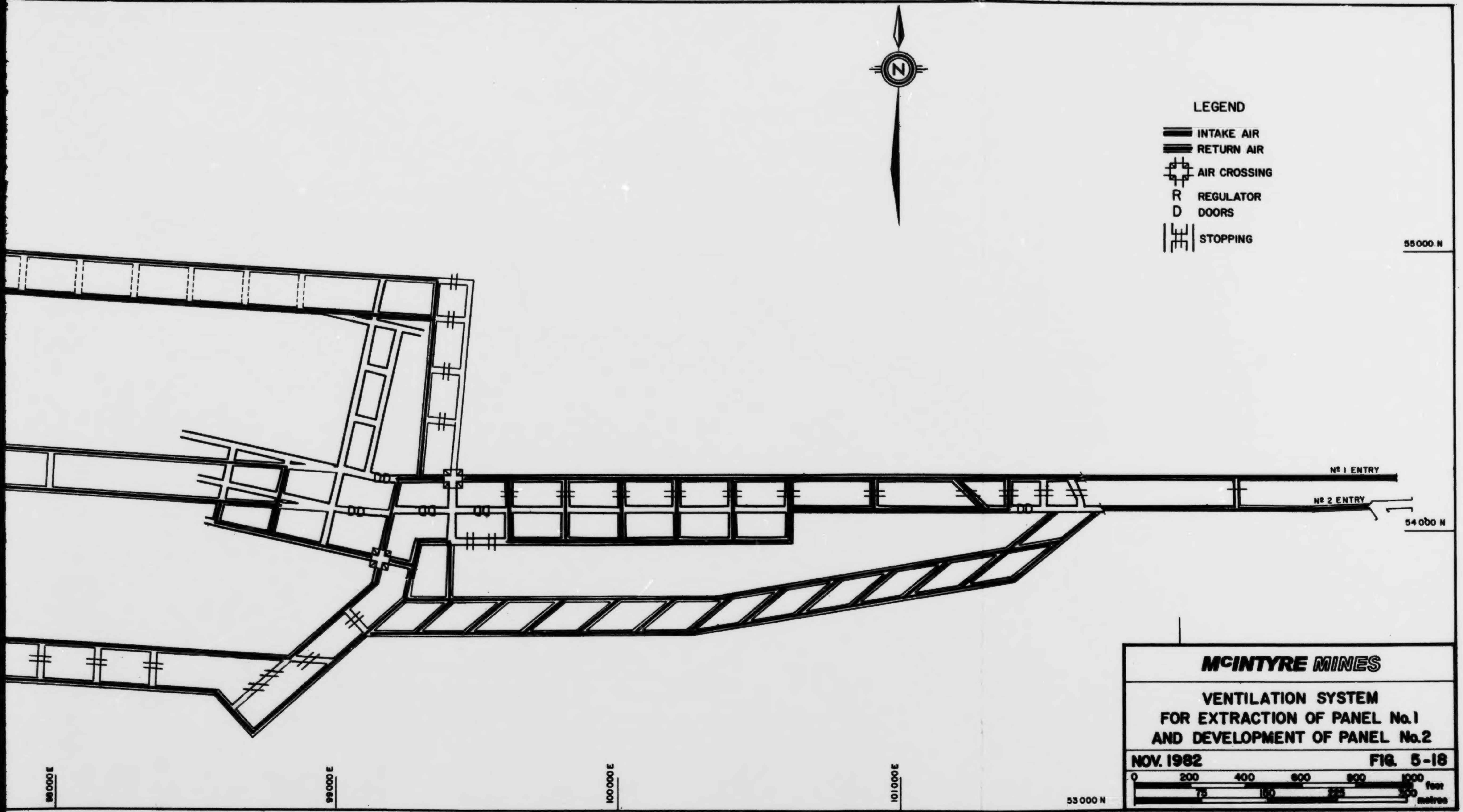
McINTYRE MINES

AUXILIARY VENTILATION FOR
TWIN ENTRY DEVELOPMENT

NOV. 1982
FIG. 5-17

Scale: N.T.S.


Nº I PANEL R.H. ROADS
WASTE (Goaf)
COAL FACE
Nº I PANEL (PRODUCTION)
Nº I PANEL L.H. ROADS
Nº 2 PANEL (L.H. ROAD DEVELOPMENT)
Nº 2 PANEL L.H. ROADS
94000 E
95000 E
96000 E
97000 E
98000 E

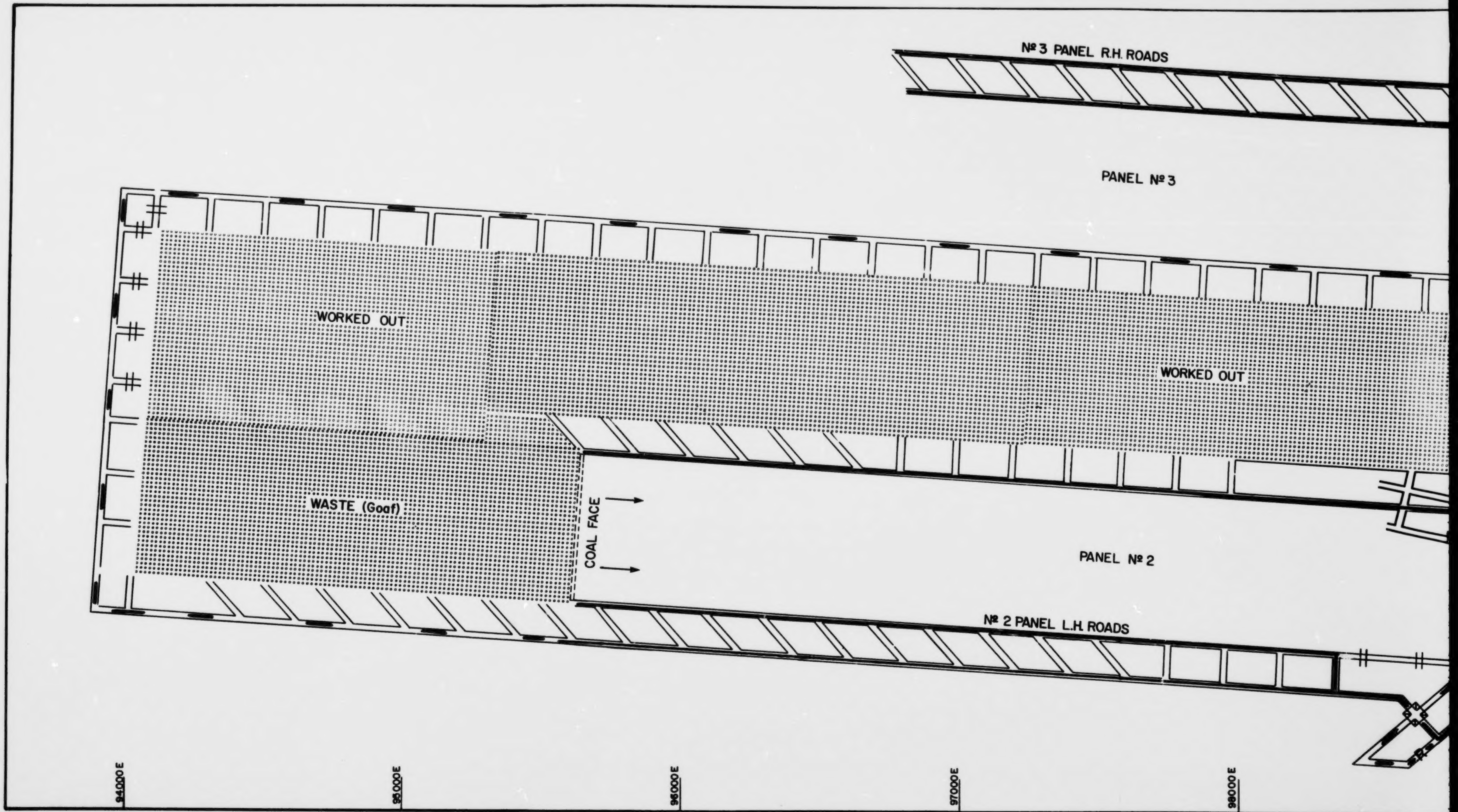


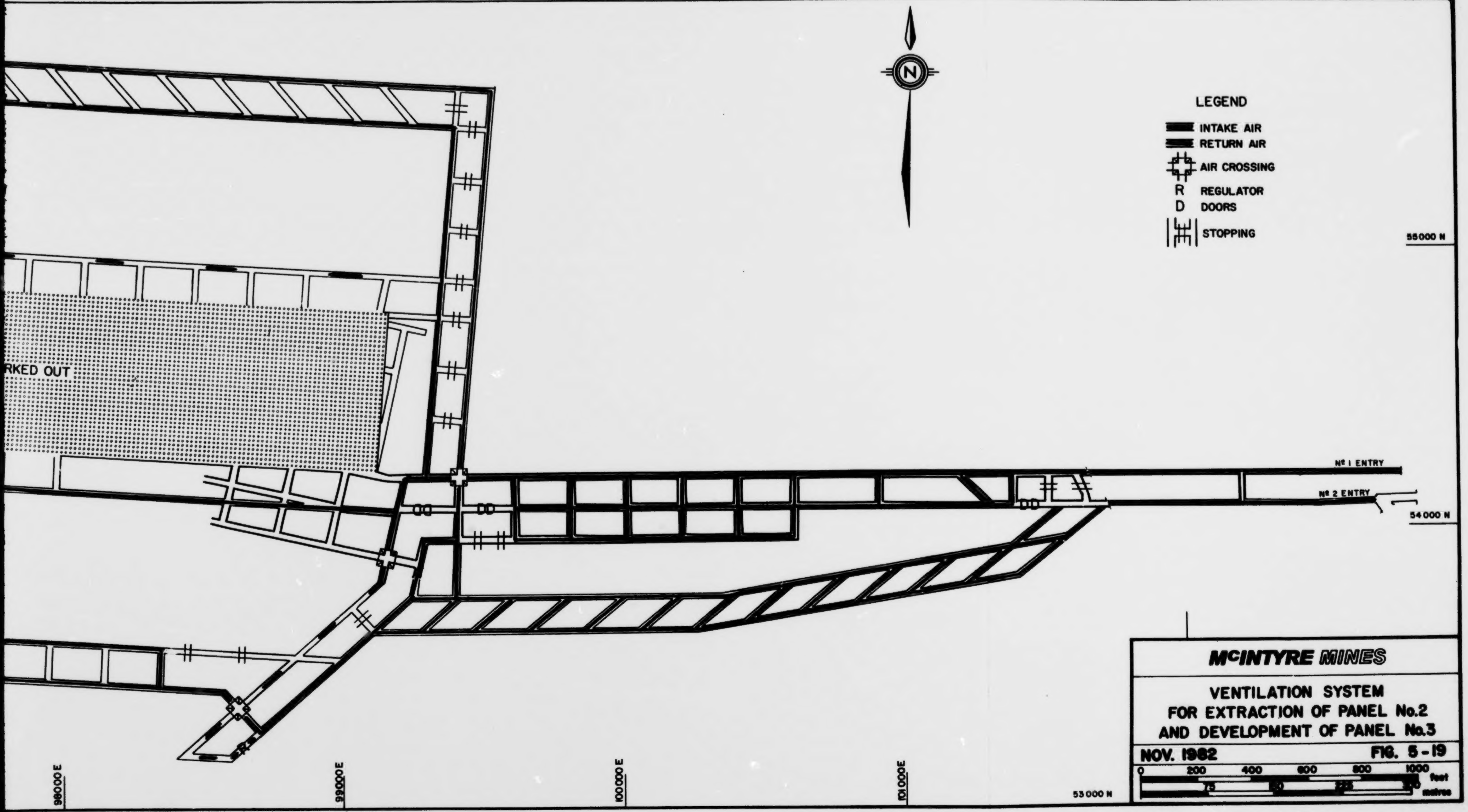
McINTYRE MINES

VENTILATION SYSTEM
FOR EXTRACTION OF PANEL No. 1
AND DEVELOPMENT OF PANEL No. 2

NOV. 1982

FIG. 5-18


Nº 3 PANEL R.H. ROADS
PANEL Nº 3
WORKED OUT
WORKED OUT
WASTE (Goaf)
COAL FACE
PANEL Nº 2
Nº 2 PANEL L.H. ROADS
94000E
95000E
96000E
97000E
98000E

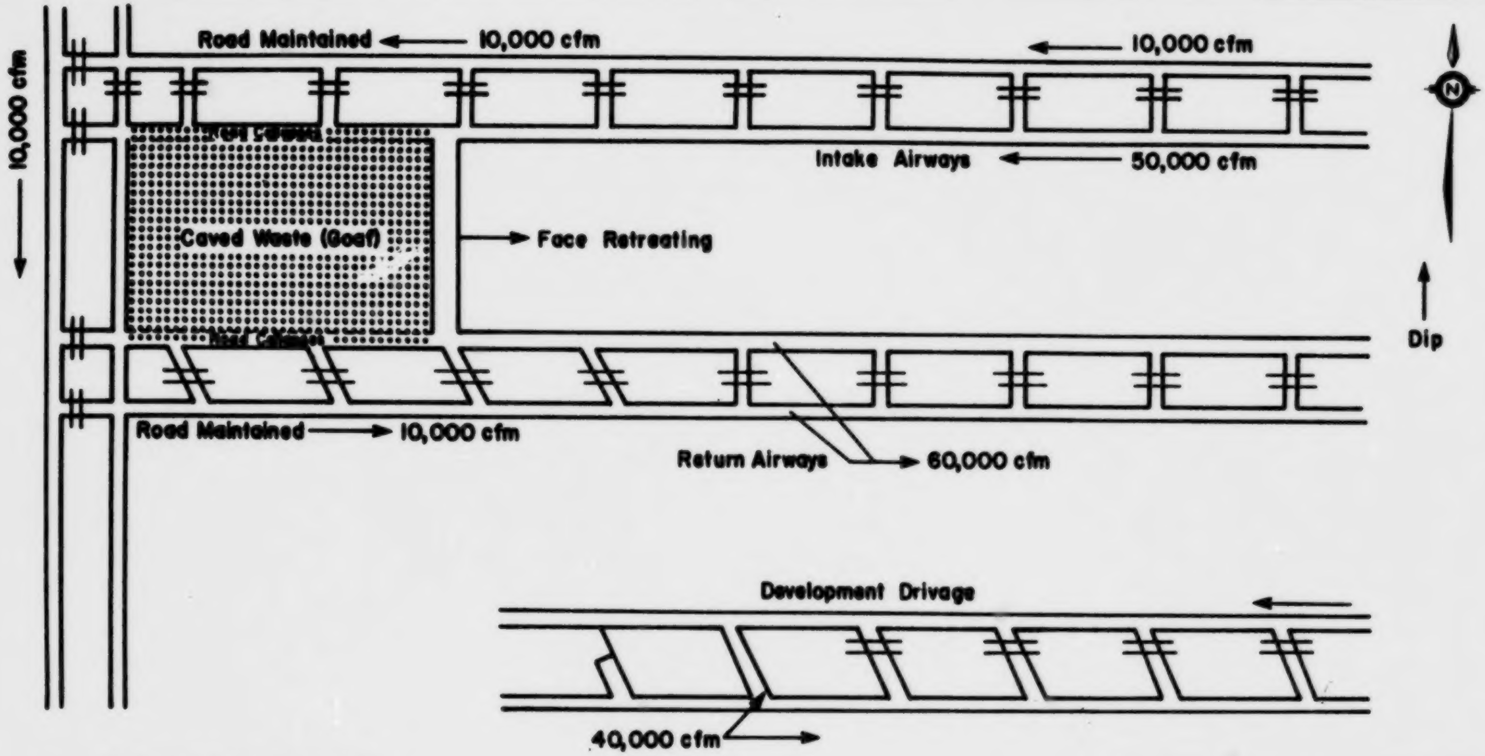


McINTYRE MINES

VENTILATION SYSTEM
FOR EXTRACTION OF PANEL No.2
AND DEVELOPMENT OF PANEL No.3

NOV. 1982

FIG. 5-19



VENTILATION REQUIREMENTS:

Development: 40,000 cfm
Face: 60,000 cfm
Total: 100,000 cfm
Volumetric Efficiency: 50%
Main Fan Quantity: 200,000 cfm

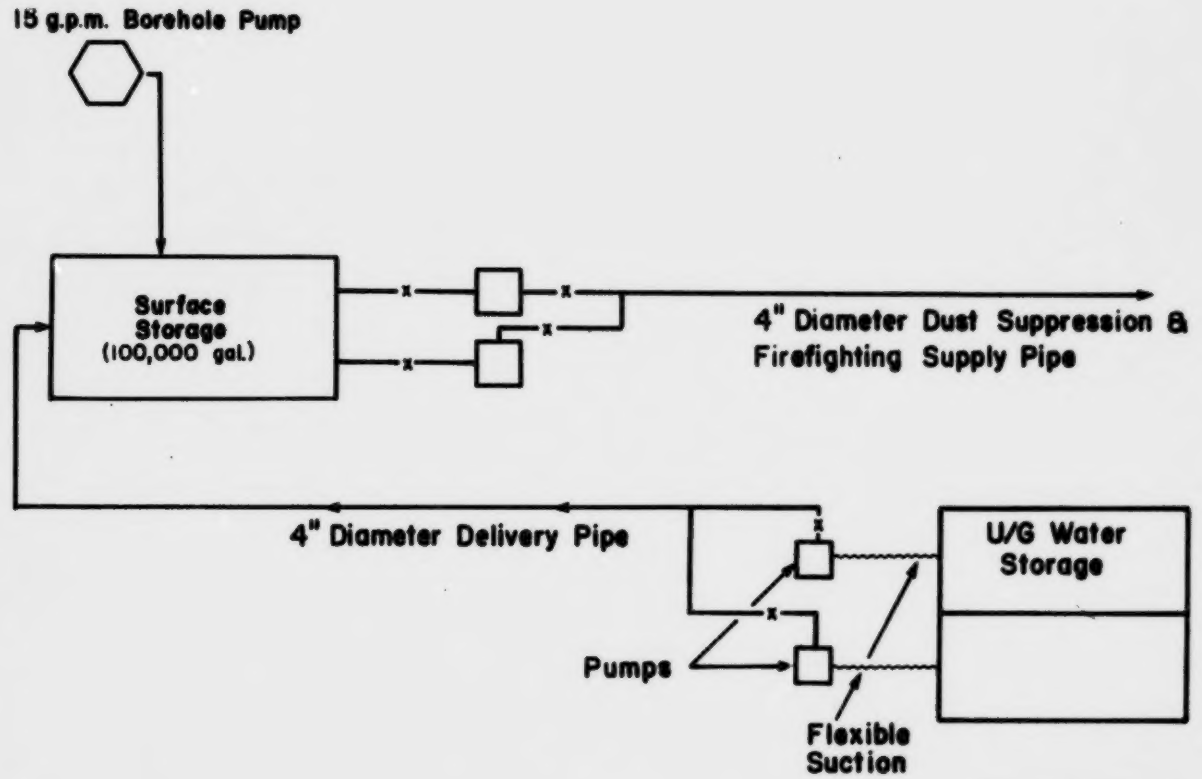
McINTYRE MINES

VENTILATION QUANTITIES
FOR LONGWALL OPERATION
AND DEVELOPMENT

NOV. 1982

FIG. 5-20

Scale: N.T.S.


15 g.p.m. Borehole Pump
Surface Storage (100,000 gal.)
4" Diameter Dust Suppression & Firefighting Supply Pipe
4" Diameter Delivery Pipe
U/G Water Storage
Pumps
Flexible Suction

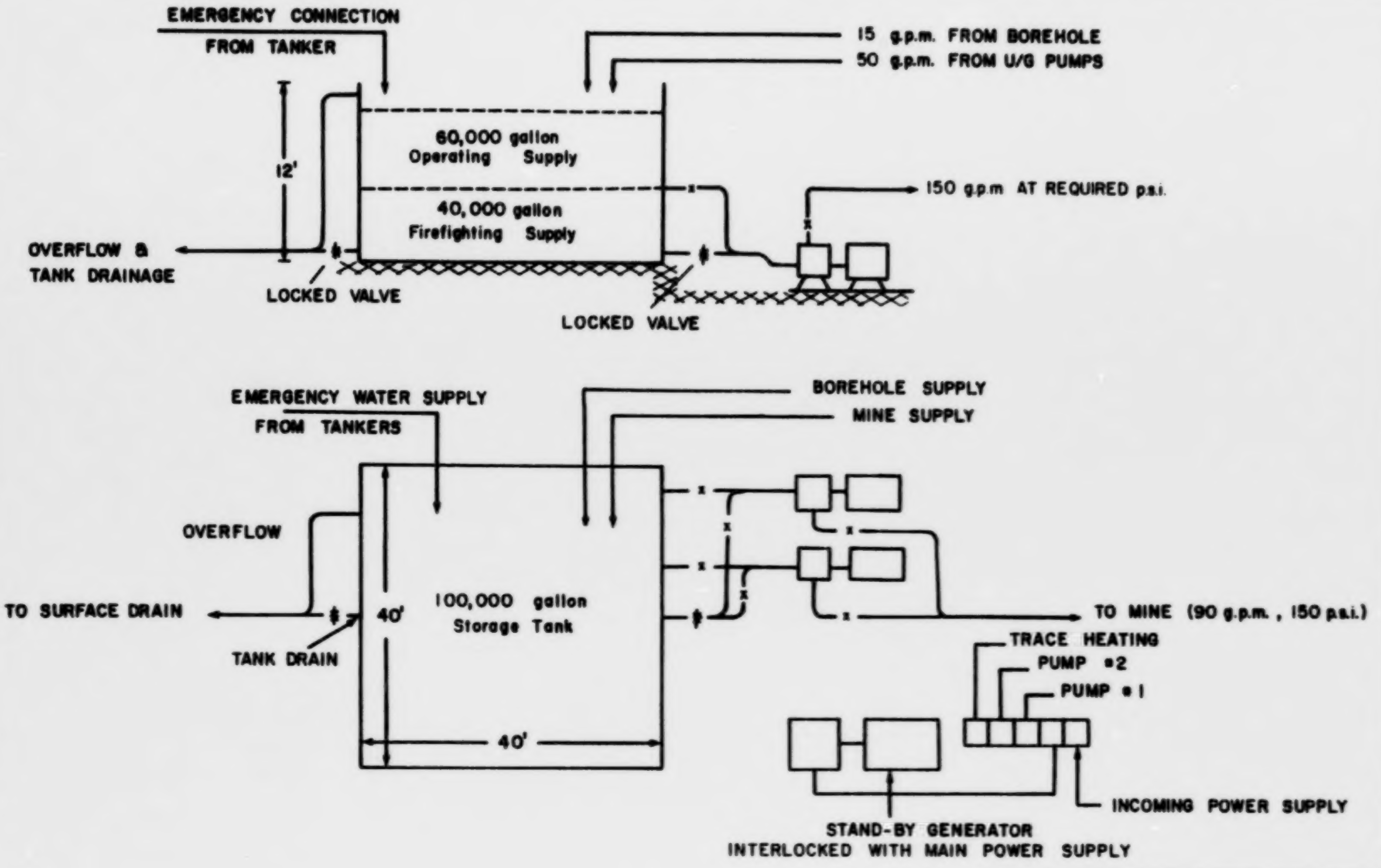
McINTYRE MINES

WATER SUPPLY SYSTEM

NOV. 1982

FIG. 5-21

Scale: N.T.S.



McINTYRE MINES

GENERAL ARRANGEMENT OF WATER
SUPPLY SYSTEMS FOR DUST
SUPPRESSION AND FIRE FIGHTING

NOV. 1982 FIG. 5-22

Scale: N.T.S.

MAIN SUMP (Suggested Design)

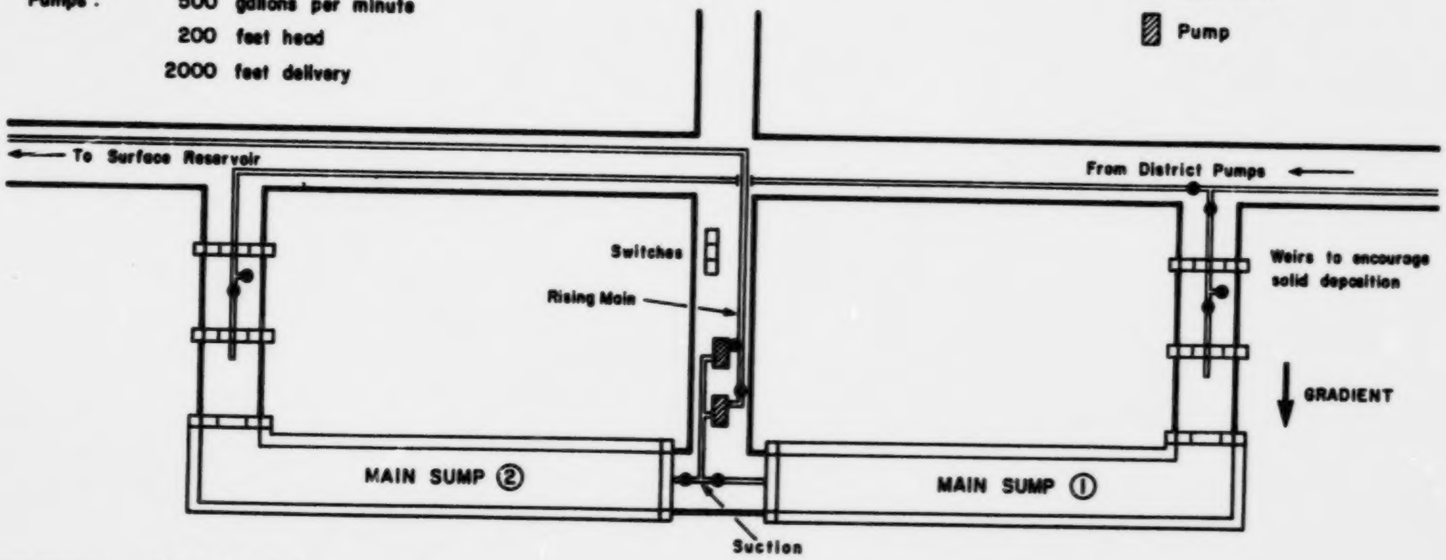
Capacity: 17 hours at 150 gallons per minute = 153,000 gallons

Pumps: 500 gallons per minute
200 feet head
2000 feet delivery

LEGEND

● Stop Valve

▨ Pump



Dimensions: 20' x 8' x 150'

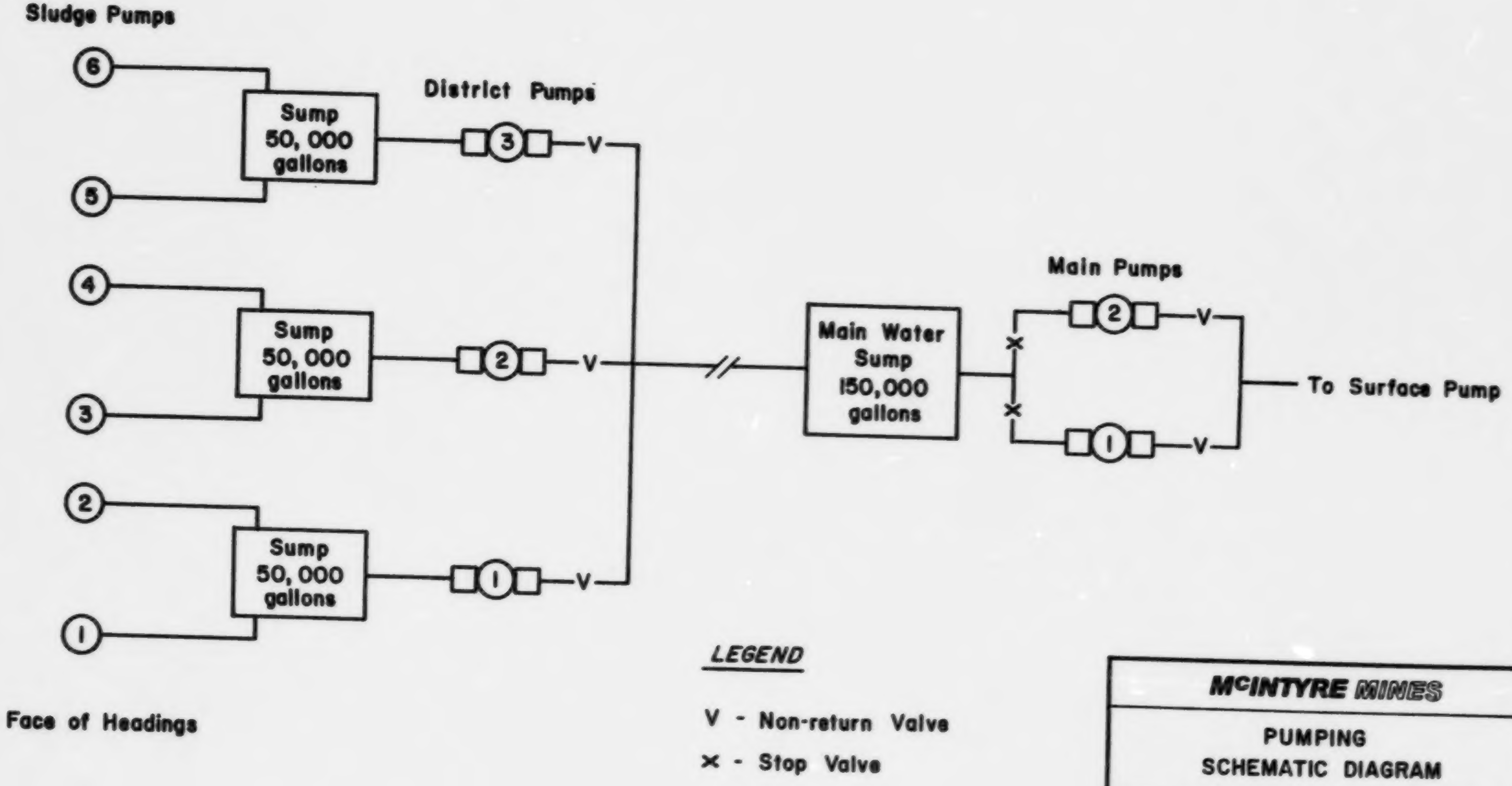
(a) Two sumps of equal capacity. Provision to clean one while the other is in use.
(b) The delivery of water to the sump is over three weirs.
(c) The weirs can be removed to allow vehicular access.
(d) Pipe valves are placed to allow either sump to be used.
(e) The Pump house is accessible by haulage transport system.

McINTYRE MINES

UNDERGROUND
PUMPING AND WATER STORAGE

NOV. 1982 FIG. 5-23

Scale: N.T.S.

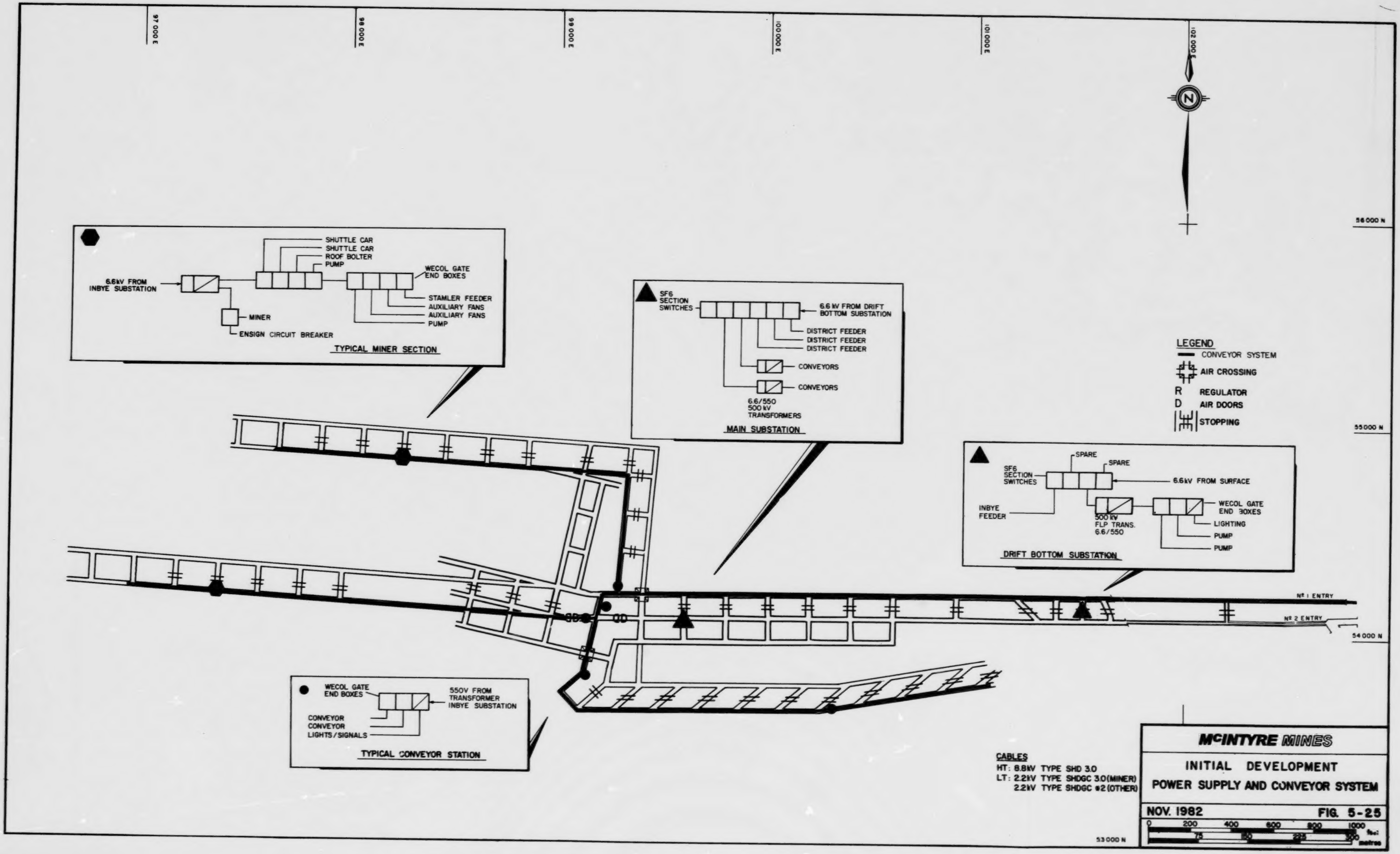


McINTYRE MINES

PUMPING
SCHEMATIC DIAGRAM

NOV. 1982 FIG. 5-24

Scale: N.T.S.



CABLES
HT: 6.6kV TYPE SHD 3.0
LT: 2.2kV TYPE SHDGC 3.0(MINER)
2.2kV TYPE SHDGC #2 (OTHER)

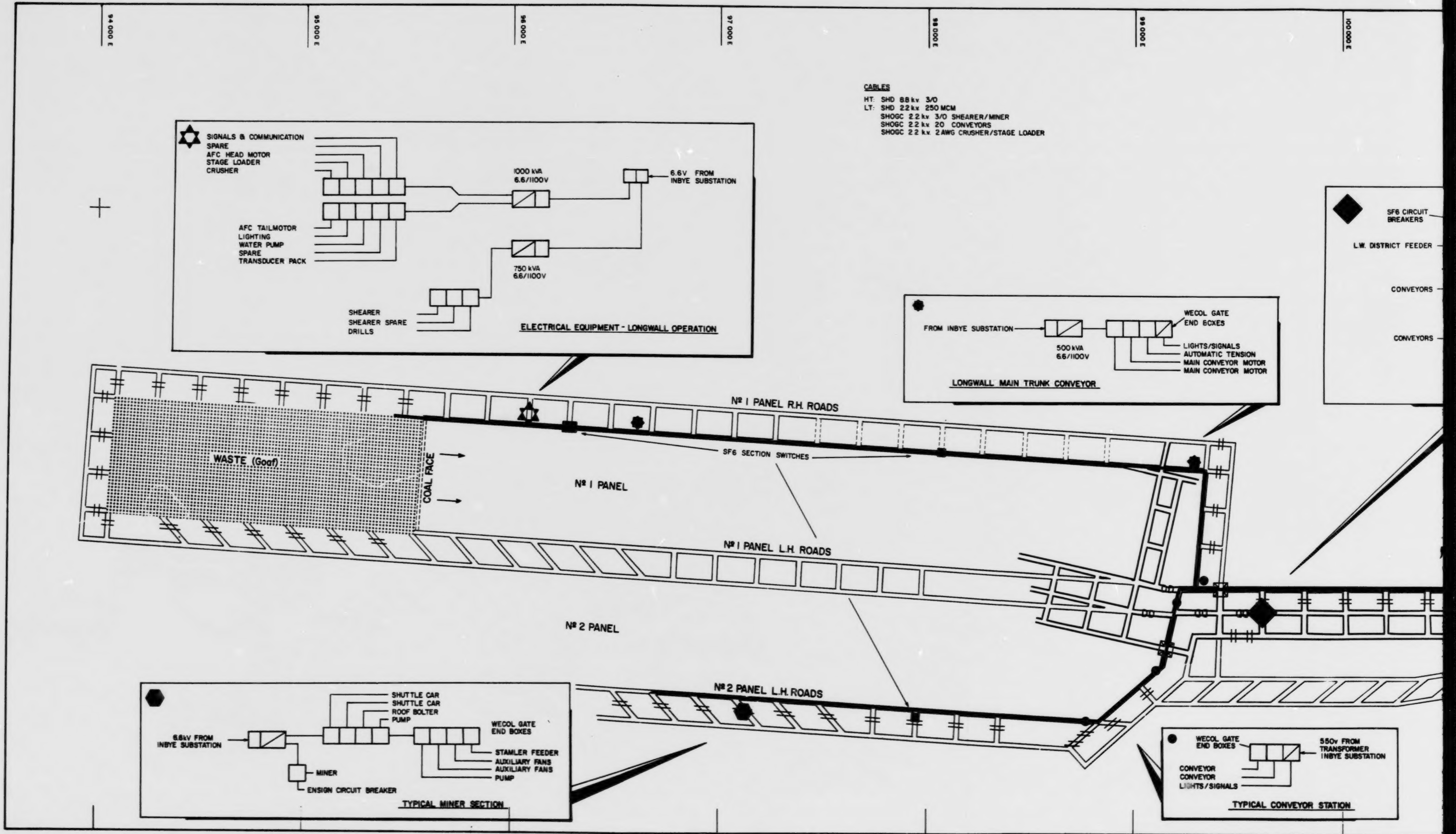
McINTYRE MINES

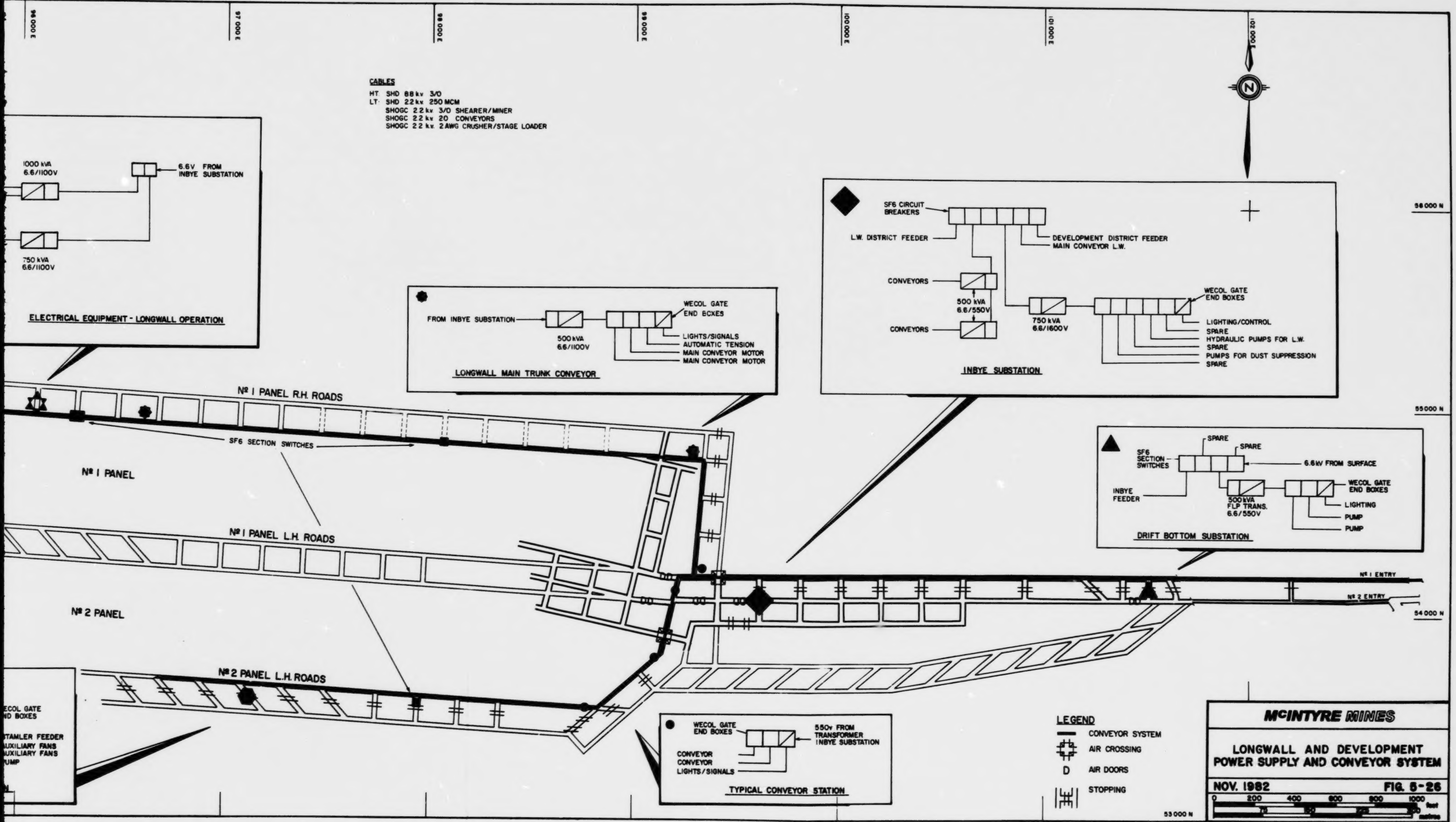
INITIAL DEVELOPMENT
POWER SUPPLY AND CONVEYOR SYSTEM

NOV. 1982

FIG. 5-25

0 200 400 600 800 1000 feet
75 150 225 300 metres


94 000 E
95 000 E
96 000 E
97 000 E
98 000 E
99 000 E
100 000 E
CABLES
HT: SHD 6.6 k.v. 3/0
LT: SHD 2.2 k.v. 250 MCM
SHOGC 2.2 k.v. 3/0 SHEARER/MINER
SHOGC 2.2 k.v. 2/0 CONVEYORS
SHOGC 2.2 k.v. 2 AWG CRUSHER/STAGE LOADER
SIGNALS & COMMUNICATION
SPARE
AFC HEAD MOTOR
STAGE LOADER
CRUSHER
1000 kVA
6.6/1100V
6.6V FROM
INBYE SUBSTATION
AFC TAILMOTOR
LIGHTING
WATER PUMP
SPARE
TRANSDUCER PACK
750 kVA
6.6/1100V
SHEARER
SHEARER SPARE
DRILLS
ELECTRICAL EQUIPMENT - LONGWALL OPERATION
FROM INBYE SUBSTATION
500 kVA
6.6/1100V
WECOL GATE
END BOXES
LIGHTS/SIGNALS
AUTOMATIC TENSION
MAIN CONVEYOR MOTOR
MAIN CONVEYOR MOTOR
LONGWALL MAIN TRUNK CONVEYOR
SF6 CIRCUIT
BREAKERS
L.W. DISTRICT FEEDER
CONVEYORS
CONVEYORS
Nº 1 PANEL R.H. ROADS
WASTE (Goaf)
COAL FACE
Nº 1 PANEL
SF6 SECTION SWITCHES
Nº 1 PANEL L.H. ROADS
Nº 2 PANEL
Nº 2 PANEL L.H. ROADS
SHUTTLE CAR
SHUTTLE CAR
ROOF BOLTER
PUMP
6.6kV FROM
INBYE SUBSTATION
WECOL GATE
END BOXES
STAMLER FEEDER
AUXILIARY FANS
AUXILIARY FANS
PUMP
MINER
ENSIGN CIRCUIT BREAKER
TYPICAL MINER SECTION
WECOL GATE
END BOXES
550v FROM
TRANSFORMER
INBYE SUBSTATION
CONVEYOR
CONVEYOR
LIGHTS/SIGNALS
TYPICAL CONVEYOR STATION



CABLES

HT. SHD 8.8 k.v. 3/0
LT. SHD 2.2 k.v. 250 MCM
SHOGC 2.2 k.v. 3/0 SHEARER/MINER
SHOGC 2.2 k.v. 20 CONVEYORS
SHOGC 2.2 k.v. 2 AWG CRUSHER/STAGE LOADER

McINTYRE MINES

LONGWALL AND DEVELOPMENT
POWER SUPPLY AND CONVEYOR SYSTEM

NOV. 1982

FIG. 5-26

McINTYRE MINES LIMITED

LONGWALL DEMONSTRATION
PHASE 1

SECTION 6 LONGWALL OPERATIONS

TABLE OF CONTENTS

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6.2	Development	6-2
	6.2.1 Mining System	
	6.2.2 Operating Sequence	
	6.2.3 Development of the Face-Line	
	6.2.4 Development Schedule	
6.3	Equipment Installation	6-5
	6.3.1 Delivery	
	6.3.2 Installation	
6.4	Longwall Operations	6-7
	6.4.1 Introduction	
	6.4.2 Sequence	
6.5	Transfer of Equipment	6-10
6.6	Longwall Performance	6-12
6.7	Development, Production, Manpower and Productivity Schedules	6-13

TABLES
(Following Text)

Table 6-1 Longwall Performance General Data
Table 6-2 Longwall Panel Statistics
Table 6-3 Longwall Performance Available Working and Equipment Cycle Times
Table 6-4 Manpower and Production Summary Demonstration Period (5-Year)
Table 6-5 Development and Production Schedule Parameters

Table 6-6 Typical Manpower Deployment Summary Longwall With One Three-Shift Development Operation
Table 6-7 Productivity Summary Demonstration Period (5-Year)

FIGURES
(Following Tables)

Figure 6-1 Support System - Development
Figure 6-2 Typical Sequence for Development Operations
Figure 6-3 Development and Production Schedule Demonstration Period (5-Year)
Figure 6-4 Longwall Equipment Installation Schedule
Figure 6-5 Longwall Mining Sequence of Operations

6.0 LONGWALL OPERATIONS

6.1 INTRODUCTION

In Section 6 each phase of the longwall operation from development, to equipment installation, production and transfer of equipment is discussed.

The successful exploitation of the longwall mining technique requires all phases from initial development to completion of mining activity be properly coordinated and controlled. Unscheduled delays can be extremely expensive, a days delay can result in the loss of thousands of tons of production. Each phase of the operation must therefore be carefully planned and executed to maximize equipment utilization and to keep unscheduled delays to an absolute minimum.

Existing equipment and current mining techniques at Smoky River will be employed to develop the twin entry roadway systems and the face-line for Panel #1. Increased seam gradients will be encountered in the drivages required for Face #2 and it is planned to employ a different type of heading machine so that the roof of the seam across the drivage remains substantially undisturbed. An example of such a machine is the Dosco LH1300 (Appendix 2-8).

The longwall equipment will vary in detail depending on the supplier, but in general the system will encompass:

- A hydraulically operated roof support system extending throughout the face and across the intake and supply roadways. The roof supports will be of the shield or chock shield configuration.

- An armoured face conveyor with double strand conveyor chain extending throughout the face and discharging to a stage loader in the intake roadway. The conveyor will accommodate a shearer and shearer haulage system and will have attachments for the powered supports.

- A double ended ranging drum shearer will mine the coal and transfer it to the face conveyor. The shearer will be mounted on a suitable underframe and be capable of travelling throughout the length of the face conveyor. The shearer will be electrically powered, equipped with hydraulic haulage, a lump breaker and comprehensive dust control systems.

- A stage loader of similar construction to the face conveyor will accept coal from the face conveyor. The stage loader structure will accommodate a lump breaker and belt conveyor return end and be capable of retraction by mechanical or hydraulic means as the longwall retreats.

- Either as an intrinsic part of the stage loader assembly, or as a separate structure capable of ready retraction, accommodation for switchgear, transformers and other control equipment will be provided.

The equipment specified will be able to accommodate a range of remote control and monitoring facilities.

6.2 DEVELOPMENT

In room and pillar mining at No. 9A-4 and No. 9G-4 Mines and other mines elsewhere roadways have been successfully driven in seams inclined at up to about 18°, despite the fact that the equipment employed is normally only capable of forming a roof line parallel to the floor. To minimize roof disturbance during development in inclined seam conditions, the roof of the heading can be extracted in a stepped manner producing the roadway profile shown in Figure 6-1. Apart from the dilution of coal by unwanted rock the method is a practical solution and no undue difficulties have been encountered either during development or depillaring activity.

Twin entry developments with a roadway profile similar to that shown in Figure 6-1 are currently successfully being driven in a 14° inclined seam in the No. 9A-4 Mine's 3 West District. This closely parallels the conditions to be anticipated at the inbye end of the drivages for the first longwall face. This experience confirms that the required drivages can be successfully completed.

The configurations of the maingate and tailgate entries on a pitch of 18° are shown in Drawings 3 and 4 of Appendix 4-1 (Drawings).

6.2.1 Mining System

Three sections would be worked to develop Panel #1. The equipment for each section comprising:

1 continuous miner
2 shuttle cars
1 Stamler Feeder
3 auxilliary ventilation fans
1 Fletcher roof bolter
1 belt conveyor

Typical specification sheets for the above equipment are shown in Appendix 2-8.

Following installation of the first longwall unit, development of replacement faces would be achieved using one development section working on two shifts.

6.2.2 Operating Sequence

The development operation is cyclic. Initially the continuous miner would advance by cutting a full roadway section for a maximum distance of 20 ft. This distance has been determined to ensure that the operators cab is always under supported roof. Coal will be loaded into shuttle cars for transport to a Stamler Feeder which accepts the rapid discharge of coal from the shuttle car and delivers the coal to a conveying system at a controlled rate. After advancing 20 ft the continuous miner will be withdrawn from the mined heading and transferred to a supported adjacent section to recommence mining.

Once the continuous miner has retreated from the mined heading the roof will be supported by drilling and installing roof bolts and 3 inch square wire mesh. Roof bolts would be correctly installed and regularly checked to ensure that the correct torque is maintained and where necessary, additional support in the form of chocks or timber props installed. On completion of this operation the roof support equipment would move to the next mined section.

Following roof bolting, side supports would be erected, stone dust applied and the ventilation system extended to within 6 ft of the face of the heading.

At intervals determined by the production rate and pillar size, ventilation equipment and the conveying system would be advanced.

Roadways would be maintained in a clean condition, coal spalling or floor heave cleaned up, and preventive measures taken to maintain good ventilation and transport conditions.

A typical sequence for development operations is shown in Figure 6-2.

6.2.3 Development of the Face-Line

At the predetermined boundary for Panel #1 the face-heading would be driven to-the-rise, using the same system as applied to roadway development. The floor of the heading would be reinforced by the use of gravel, concrete or wooden sleepers to assist in the transportation and placement of the longwall equipment.

6.2.4 Development Schedule

Initially three development sections would operate on three shifts per day. Following commencement of operations on Panel #1 this would reduce to one development unit operating on two shifts per day.

Development on three shifts would advance 100 ft and produce 625 tons per day (Table 6-5, Figure 6-3).

6.3 EQUIPMENT INSTALLATION

6.3.1 Delivery

Prior to the delivery of the longwall equipment it will be ensured that:

- An adequate site is available and prepared at the mine surface to accept the equipment. The site will be designed so that all the equipment can be stored in discrete sections to allow for easy transportation into the mine in the required sequence.
- An area will be defined and prepared to allow for the assembly of the two face-end sections and a limited conveyor length in order to demonstrate equipment compatibility and to provide limited training for supervisors and operators.
- An adequate power supply will be available at the mine surface to allow the equipment to be energized for the demonstration.

- Equipment capable of lifting, placing and transporting the longwall equipment will be available and operators of such equipment properly trained. This will be particularly important for the operators of the chock transporters.
- The longwall face and other important sites such as the remote pumping station will be completed and properly prepared to accept the equipment.
- The roadways along which the equipment must be transported will be in good repair and of adequate cross-section to allow free passage of the equipment.
- All necessary lifting and positioning equipment required for use below ground will be available and installed and operators will be properly trained in the use of such equipment.
- Supervisory and operating staff will have undertaken preliminary familiarization and operator training programs.

6.3.2 Installation

A compatibility trial and limited surface training will take about 3 to 4 weeks. During this time the longwall face support equipment will be installed and commissioned. This includes:

- The conveyor drives and automatic loop take-up for the main gate belt.
- The remote pumping station, tanks, emulsion mixing systems and supply lines.
- The longwall face HT power supply system, cables and transformers.

Upon completion of the compatibility trial the longwall equipment would be dismantled and prepared for transportation into the mine. To ensure that installation proceeds in an efficient and orderly manner, an installation schedule will be prepared in collaboration with the manufacturers. The schedule identifies the sequence for equipment transportation and installation and the timing of installation operations based upon transporation capabilities.

To minimize the time for equipping the longwall, installation will be undertaken from each roadway. Initally, a short length of face adjacent to the intake road will be equipped with face supports and face conveyor sections. A barrier will be erected across the face-line to protect persons working in this section from rolling or falling objects.

Additional face-line support and conveyor structure equipment will then be transported to the face-line via the return roadway and transported down the face for installation. At the same time equipment such as the shearer, main face-conveyor drive unit, stage-loader, control switchgear and gate road supports will be transported along the intake roadway for installation.

A typical installation schedule conservatively based upon the installation of one face support and associated equipment in each operating shift is shown in Figure 6-4. Installation is estimated to take 8 weeks.

6.4 LONGWALL OPERATIONS

6.4.1 Introduction

To ensure the success of longwall mining the operation must be subject to continuous scrutiny and attention to detail:

- The face will be maintained in a straight line.
- Maintenance will be performed at prescribed intervals.
- Minor faults on equipment will be rectified immediately.

- Mining standards will be maintained and the sequence adopted consistently followed.

Failure to comply with such basic operational rules can result in eventual production loss.

6.4.2 Sequence

There are several feasible sequences for operating the longwall. These include conventional, one web back, half face and single pass systems. All have different characteristics. For illustration one typical sequence is described. In practice modifications might be made when the specific mining conditions were evaluated from actual operations.

At the commencement of mining the face-conveyor line will be straight. The shearer will be located at the intake-end of the face with the drums free to rotate in a previously mined section at the face-end and the supports advanced (Figure 6-5 Stage 1).

To mine coal the drums are rotated and the shearer travels from the intake roadway to the return roadway. The right hand drum will be positioned to take the top section and cut along the roof of the seam. The left hand drum will be positioned to cut an additional 2 to 3 ft of the coal seam below the section cut by the right hand drum. Movement of the shearer from the intake to the return roadway extracts the top 70% of the coal seam. After the shearer has travelled away from the face-end for about 60 ft, the conveyor will be moved to the coal face at the main gate end and the supports advanced (Figure 6-5 Stage 2).

After the shearer has reached the return-end of the face the right hand drum of the shearer will be lowered to the required floor level and the direction of the shearer reversed to travel from the return to the intake road. The left hand drum freewheels until the shearer reaches a position adjacent to the snaked conveyor section.

At this location the left hand drum will be raised to extract the top section of the seam and the shearer cuts out to the intake roadway. It would be necessary to carefully adjust the position of both drums and "shuttle" the shearer by changing cutting direction to ensure that the required floor and seam profile is obtained.

Once the shearer has completed this operation it will remain in the snaked area until the conveyor is moved to the face to form a straight line and supports are advanced before recommencing the cutting cycle (Figure 6-5 Stage 3).

Employment of this sequence has several advantages:

- Most of the coal is removed while mining from intake to return. The major portion passes under the machine and through the machine lump breaker so minimizing problems caused by large lumps of coal on the conveyor system.
- The conveyor and supports are advanced in sequence from intake to return-end, up-gradient. This will assist in controlling conveyor creep down the face-line.
- Persons employed on the shearer and support operations work in the intake airstream.

To ensure that mining can proceed without interruption:

- The road-heads will be properly prepared and sufficient room provided for shearer snake and conveyor advance.

- The stage loader and conveyor system will be prepared for retraction as the face retreats.
- All surplus material such as water pipes, cables, belt structure, etc. which become redundant as the face retreats will be removed on a regular basis.

While geological and geotechnical data show that major disturbances would not be encountered during mining operations, the possibility does exist that small faults, rolls, small areas of weak roof and floor and excessive water on the face may be encountered. These possibilities were taken into account in developing equipment specifications and the equipment purchased will be sufficiently flexible to combat hazards of this nature.

The longwall support operating height can be varied between 8 to 14 ft and this capability can be used to select an appropriate mining horizon should faults or rolls be encountered. Supports would be equipped with base-lifting jacks which can assist in overcoming soft floor problems. Both the shearer and armoured face conveyor have sufficient HP to overcome problems of hard cutting and wet fines conveying.

The mining team, particularly the supervisors, will have extensive background experience in longwall operations and of working in a wide range of conditions.

6.5 TRANSFER OF EQUIPMENT

Following completion of each panel the equipment must be transferred in total to equip the replacement panel. The transfer and re-installation of equipment must be effected in an efficient and timely manner to ensure continuity of output and minimize production losses. The transfer must be properly planned, scheduled and controlled in a similar manner to the initial installation, with particular attention being paid to suitability of the transportation routes and new face-line to accommodate the equipment.

Before each panel is mined-out equipment to be transferred would be carefully examined to determine if it requires overhaul or minor repair. Based upon the results of such examinations a decision on the repair/overhaul would be made to ensure that this is completed before transfer or before re-installation. Such procedures would be carefully scheduled and detailed to ensure that at the commencement of the operations on the new face all equipment is totally sound.

Approximately 30 ft before the face finish line, weldmesh panels would be placed over the supports and interlinked by the use of helicoil clips to form a complete cover. After each advance of the conveyor additional weldmesh panels would be added to form a barrier to the encroaching waste when the supports are finally removed. The use of weldmesh also facilitates the setting of temporary supports following removal of the face supports. To allow additional room on the face to assist in the removal and transfer of equipment after the final shear has been taken, the conveyor will be advanced but the supports will not. Depending upon mining conditions at the final face line it may be possible to provide roof support by the use of wooden props and bars, but it is probable that steel supports may be required.

The sequence for removal of the equipment would be developed closer to the time of implementation as this can be affected by the mining conditions at the time. Removal and reinstallation schedules and systems must take account of local conditions.

Generally, as in the case of Panel #1, an arrangement which allows equipment installation from each end of the face is advantageous.

Following removal of equipment from the face-line, the roadways would be securely fenced off to prevent access to the mined out area and provision made to allow for environmental monitoring of methane and other gasses as a preventive measure.

6.6 LONGWALL PERFORMANCE

Coal production from longwall operations can be influenced by many factors. The most severe interruptions to production usually occur as a result of abnormal geological conditions. The geological and geotechnical data for the proposed site indicate that the mining conditions will be reasonable. Provided operations are conducted in an efficient and orderly manner no significant delays occasioned by difficult mining conditions are anticipated.

To achieve the required levels of production on a continuous basis the workforce and supervisory personnel must be familiar with the equipment and mining system. In addition to initial training provided there would be a "run in" period during which minor modifications to the system may be required and the workforce becomes familiar with the equipment and systems. Table 6-1 provides general data for the calculation of longwall production performance.

Production levels which can be attained by operating the system on a 5-day week 3 shift per day basis are shown in Table 6-2.

Table 6-2 column 1 shows the projected production rate for the longwall if the shearer is consistently operated at its maximum speed of 25 fpm. The calculations allow a 15 minute operational delay for each complete cycle.

Table 6-2 column 2 shows the potential performance at a reduced shearer speed of 18 fpm including a 15 minute operational delay for each cycle. This is a realistic expectation of shearer performance based upon experience at other longwall operations with similar coal seam characteristics.

Table 6-2 column 3 shows the anticipated performance levels with a face performance index of 80% based on the potential performance. The anticipated performance is used as the basis for production scheduling, economic assessment, and productivity calculations.

Table 6-3 shows the derivation of available working and machine cycle times.

6.7 DEVELOPMENT, PRODUCTION, MANPOWER AND PRODUCTIVITY SCHEDULES

Based on the development capability of existing equipment and anticipated longwall performance and manpower requirements, a development and production schedule (Figure 6-3) and a manpower deployment schedule (Table 6-4) have been prepared.

For the purpose of economic assessment and productivity calculation an overall average of 12% is used as an allowance for overtime coverage.

Table 6-5 provides in summary form the basic data used to derive the development and production schedule for the duration of the 5-year demonstration period.

Table 6-6 identifies the manpower required by job for the longwall and total mine. Table 6-7 provides productivity data and summary for the total demonstration period.

The development and production schedule and productivity summary show that:

- The first longwall face will be developed and ready to accept longwall equipment after 170 working days.
- Replacement longwall faces will be made available in ample time.
- During the demonstration period development crews would be available from the manpower allocated to develop access to additional resources.
- Annual production during the demonstration period in tons of clean coal will be:
    - ° Year 1 312 135
    - ° Year 2 728 978
    - ° Year 3 749 789
    - ° Year 4 611 472
    - ° Year 5 358 012
- Output per manshift would be 8.85 tons of clean coal in year 1, increasing in years 2 through 5 to an average of 19 tons for the total demonstration period.

The schedules have been used as the basis for the economic evaluation of the project (Section 9).

TABLE 6-1

McINTYRE MINES LIMITED

LONGWALL PERFORMANCE GENERAL DATA

PANEL #1

ITEM		VALUE	REMARKS
1. Panel		1	
2. Duration of Mining		Retr.	
3. Seam		4	
4. Gradient	(degrees)	18-4	
5. Worked Height	(feet)	10	
6. Face Length	(feet)	550	
7. Panel Length	(feet)	4800	
8. Web Depth	(feet)	2.25	
9. Shearer type		DERDS	
10. Shifts per Day		3	
11. Travel Time*	(mins)	60	
12. Meal Time	(mins)	30	
13. A.W.T. per Shift	(mins)	390	
14. A.W.T. per Day	(mins)	1170	
15. Manshifts per Day	(face)	56	Includes overtime at 12%
16. Manshifts per day	(overall)	168	
17. Yield of Clean Coal	(percent)	72.5	

A.W.T. Available Working Time
Weight 26 cubic feet per ton

* Includes 10 minutes preparation time.

TABLE 6-2

McINTYRE MINES LIMITED

LONGWALL PANEL STATISTICS

REFERENCE		MACHINE CAPACITY	PROJECTED PRODUCTION	ANTICIPATED PRODUCTION
18. Tons per Shear		476	476	476
19. Cutting Rate	(ft/min)	25	18	-
20. Max Load on AFC	(tons/hr)	908	654	654
21. Cycles per Shift		4.6	3.82	3.06
22. Cycles per Day		13.8	11.46	9.18
23. Output per Shift	(LTR)	2190	1818	1457
24. Output per Day	(LTR)	6569	5454	4370
25. Advance per Shift	(feet)	10.35	8.6	6.90
26. Advance per Day	(feet)	31.00	25.8	20.7
27. Advance per Week	(feet)	155	129	103.5
28. Panel Life	(days)	155	186	232

TABLE 6-3

LONGWALL PERFORMANCE AVAILABLE WORKING AND EQUIPMENT CYCLE TIMES

Available Working Time Per Shift

Shift Length - (travelling time + preparation + meal) = AWT

480 - (50 + 10 + 30) = 390 minutes

ASSESSMENT OF CYCLE TIME FOR A FACE LENGTH OF 550 FT

ACTIVITY		CYCLE TIME	
		PRODUCTION CAPABILITY	POTENTIAL PERFORMANCE
Cutting Speed	ft/min	25	18
Cut Gate Tail-End	(mins)	22	31
Turnround	(mins)	10	10
Cut Tail Gate-End	(mins)	22	31
Turnround	(mins)	15	15
Operational Delays	(mins)	15	15
Total Time	(mins)	84	102

TABLE 6-4

MANPOWER AND PRODUCTION SUMMARY
DEMONSTRATION PERIOD (5-YEAR)

DAYS		146	24	40	198	12	22	40	190	61	40	272
DURATION		0 - 146	146 - 170	170 - 210	210 - 408	408 - 420	420 - 442	442 - 482	482 - 672	672 - 733	733 - 773	773 - 1045
Manpower												
Development	Hourly	90	90	20	20	20	20	20	20	-	-	-
	Staff	9	9	2	2	2	2	2	2	-	-	-
	Total	99	99	22	22	22	22	22	22	-	-	-
Longwall	Hourly	-	-	60	56	56	56	56	56	56	56	56
	Staff	-	-	6	7	7	7	7	7	7	7	7
	Total	-	-	66	63	63	63	63	63	63	63	63
Others	Hourly	33	33	33	33	33	33	33	33	33	33	33
	Staff	21	21	21	21	21	21	21	21	21	21	21
	Total	54	54	54	54	54	54	54	54	54	54	54
Total	Hourly	123	123	123	109	109	109	109	109	89	89	89
	Staff	30	30	29	30	30	30	30	30	28	28	28
	Overall	153	153	142	139	139	139	139	117	117	117	117
Daily Production (LTR)	Development	1 875	1 250	412	417	-	417	417	417	-	-	-
	Face	-	-	-	4 370	4 370	4 370	-	4 370	4 370	-	4 370
	Total	1 875	1 250	417	4 787	4 370	4 787	417	4 787	4 370	-	4,370
Daily Production (LTC)	Total	1 354	906	302	3 470	3 168	3 470	302	3 470	3 168	-	3 168

TABLE 6-5

DEVELOPMENT AND PRODUCTION SCHEDULE PARAMETERS

The development and production schedules are built up on the following criteria:

1.	Days in the year	52 x 5	260
2.	Effective work days		233
3.	Face transfers (work 7 day week: 56 days)		40

Development Rates in all Drivages

1.	Feet per day	100
2.	Tons per foot	6.25
3.	Tons per day	625

Production Schedule (Longwall)

During the initial phase of operations of each longwall panel there will be a "running in" period during which production levels will be reduced.

It is estimated that this period will extend for some 20 days and that for the first 10 days one shear per shift will be achieved and for the second ten days two shears. The average daily production would be reduced by approximately 3% from 4370 to 4224 LTR per day. Since the longwall production levels used are already de-rated by 20% and conservative rates are used for development performance this is not considered significant and the base case production and development rates have beeen applied to derive the appropriate development and production schedules (Figure 6-3).

Tons Per Strip

Face length	feet	550
Mining height	feet	10
Strip	feet	2
Coal (weight)	cu. ft/ton	26
Tons per Strip	550 x 10 x 2.25 ÷ 26 tons	476

TABLE 6-6

TYPICAL MANPOWER DEPLOYMENT SUMMARY
LONGWALL WITH ONE THREE SHIFT DEVELOPMENT OPERATION

LONGWALL FACE	SHIFT		
	D	A	N
Shearer Operator	2	2	2
Supports Movement	3	3	3
Intake Roadhead	2	2	2
Return Roadhead	2	2	2
Support Maint.	1	1	1
Mechanic	1	1	1
Electrician	1	1	1
Stage Loader	1	1	1
Between Shift Maint.			4
Supervisors (Fireboss)	2	2	3
TOTAL	15	15	20

LONGWALL DISTRICT	SHIFT		
	D	A	N
Roadway Preparation			
Intake	2		
Return	2		
Salvage	3		
Methane Drainage			
Supplies Transport	2	2	2
TOTAL	9	2	2

DEVELOPMENT	SHIFT		
	D	A	N
Miner Operator	2	2	2
Roof Bolt	2	2	2
Shuttle Car	2	2	2
Side Support	1	1	1
Mechanics	1	1	1
Electrician	1	1	1
Supplies	1	1	1
Fireboss	1	1	1
TOTAL	11	11	11

OUTBYE WORKERS	SHIFT		
	D	A	N
Road Repair		2	2
Belt Patrol	2	2	2
Pumps	1		
Ventilation	2		
Fireboss	1	1	1
Senior Foremen	1	1	1
TOTAL	7	6	6

9G SURFACE	SHIFT		
	D	A	N
Portal & First Aid	1	1	1
Drivers	1	1	1
Foreman Mechanic	1	1	1
Electric	1	1	1
Janitors	1		1
TOTAL	5	4	5

WORKSHOP	SHIFT		
	D	A	N
Mechanic	2	2	2
Electrician	2		
Welder	1	1	1
Machine Operator	1		
TOTAL	6	3	3

OTHERS	SHIFT		
	D	A	N
Planner	1		
Surveyor	2		
Air Dust, etc.	1		
Safety/Rescue	1		
Clerk	1		
Training			
Elect. Mech.	2		
Undermanager	1		
TOTAL	9		

SUMMARY	SHIFT		
	D	A	N
Longwall Face	15	15	20
Longwall District	9	2	2
Development	11	11	11
Outbye: E.B.G.	7	6	6
Surface 9G	5	4	5
Workshop	6	3	3
Others	9		
TOTAL	62	41	47
	150		

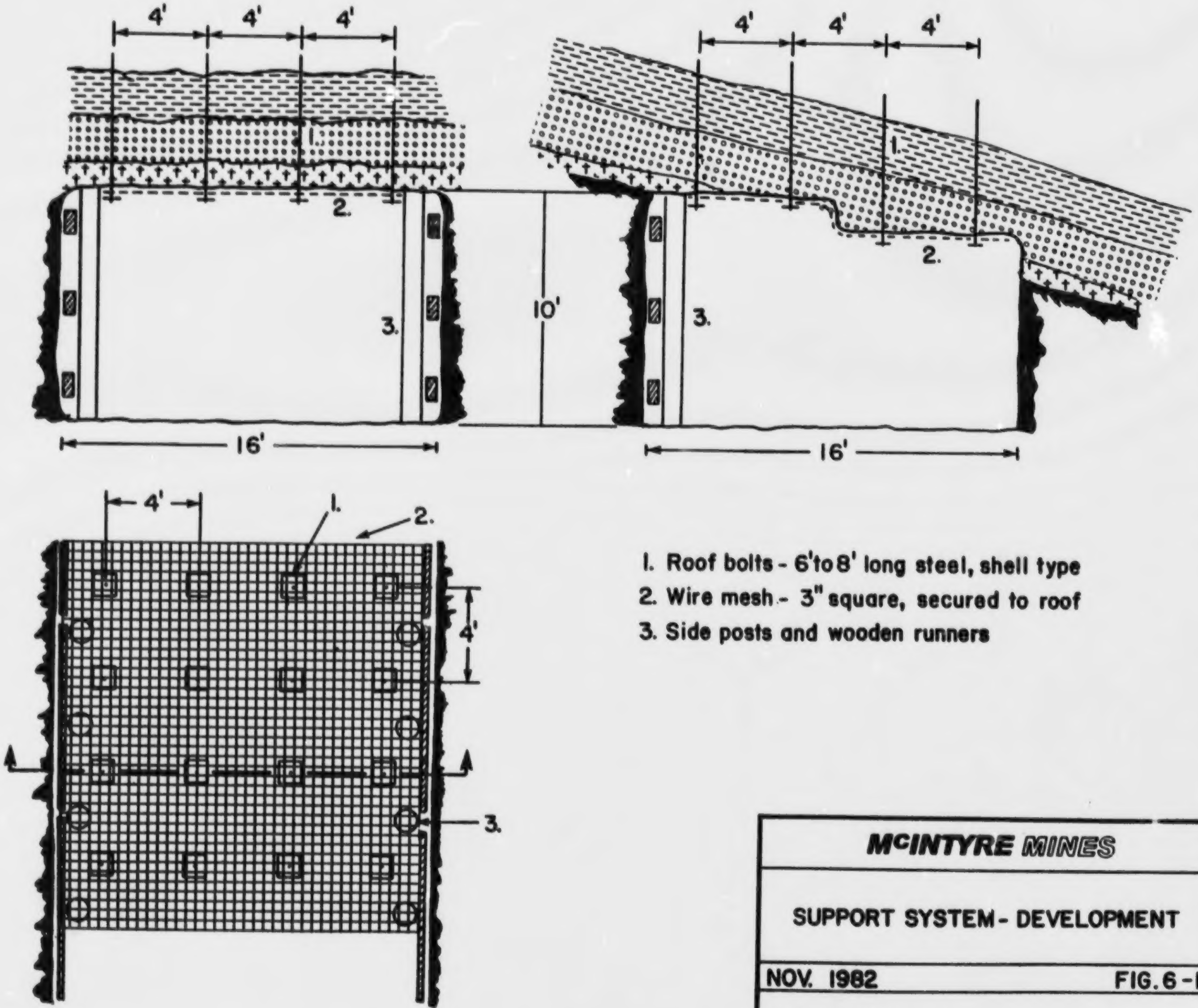
EBG - Elsewhere below ground

TABLE 6-7

PRODUCTIVITY SUMMARY
DEMONSTRATION PERIOD (5-YEAR)

DAYS CUMULATIVE	0-146	146-170	170-210	210-408	408-420	420-442	442-482	482-672	672-733	733-773	773-1045
DAYS	146	24	40	198	12	22	40	190	61	40	272
Total Manpower Requirements	153	153	142	139	139	139	139	117	117	117	117
Overtime Allowance	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%
Total Daily Shifts	172	172	159	155	155	155	155	131	131	131	131
Daily Production (clean tons/equivalent)	1354	906	302	3470	3168	3470	302	3470	3168	Nil	3168
Output Per Manshift Total Mine (clean tons/equivalent)	7.9	5.3	6.74	22.3	20.35	22.3	1.94	26.48	24.17	-	24.17
* Average Output Per Manshift for Demonstration Project					19.0 LTC						

NOTE: Productivity calculations only consider the manpower necessary to deliver coal to the mine-mouth stockpile.



1. Roof bolts - 6' to 8' long steel, shell type
2. Wire mesh - 3" square, secured to roof
3. Side posts and wooden runners

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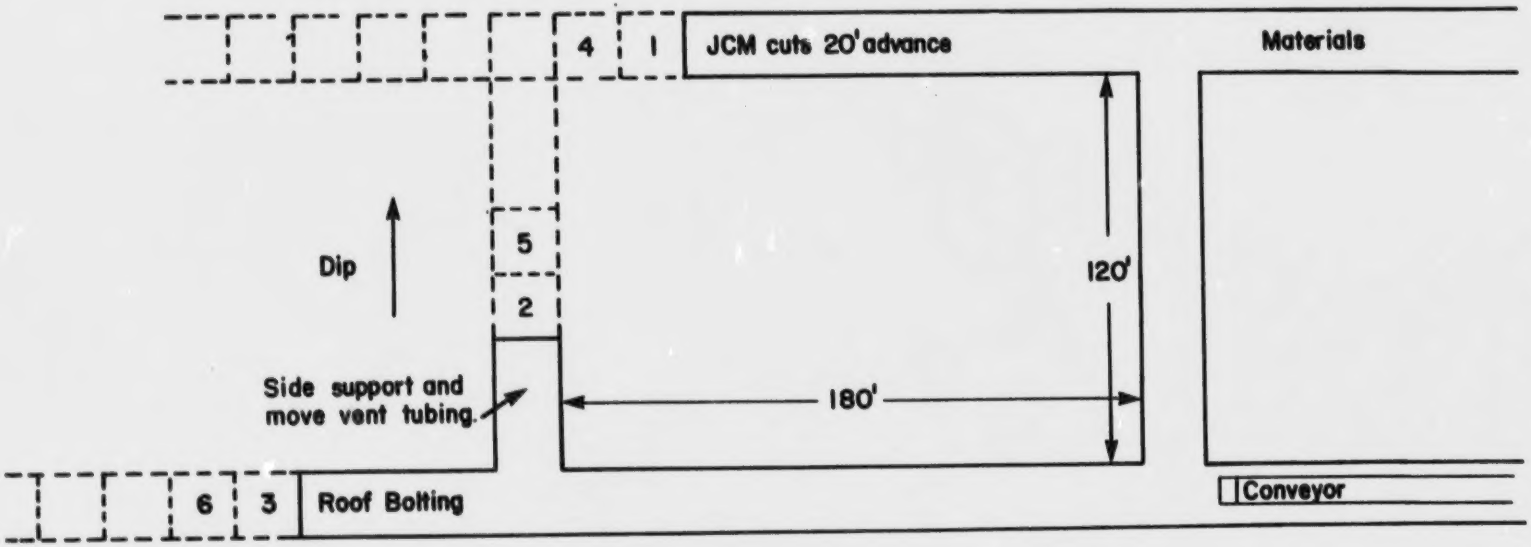
SUPPORT SYSTEM - DEVELOPMENT

NOV. 1982

FIG. 6-1

Scale: N.T.S.



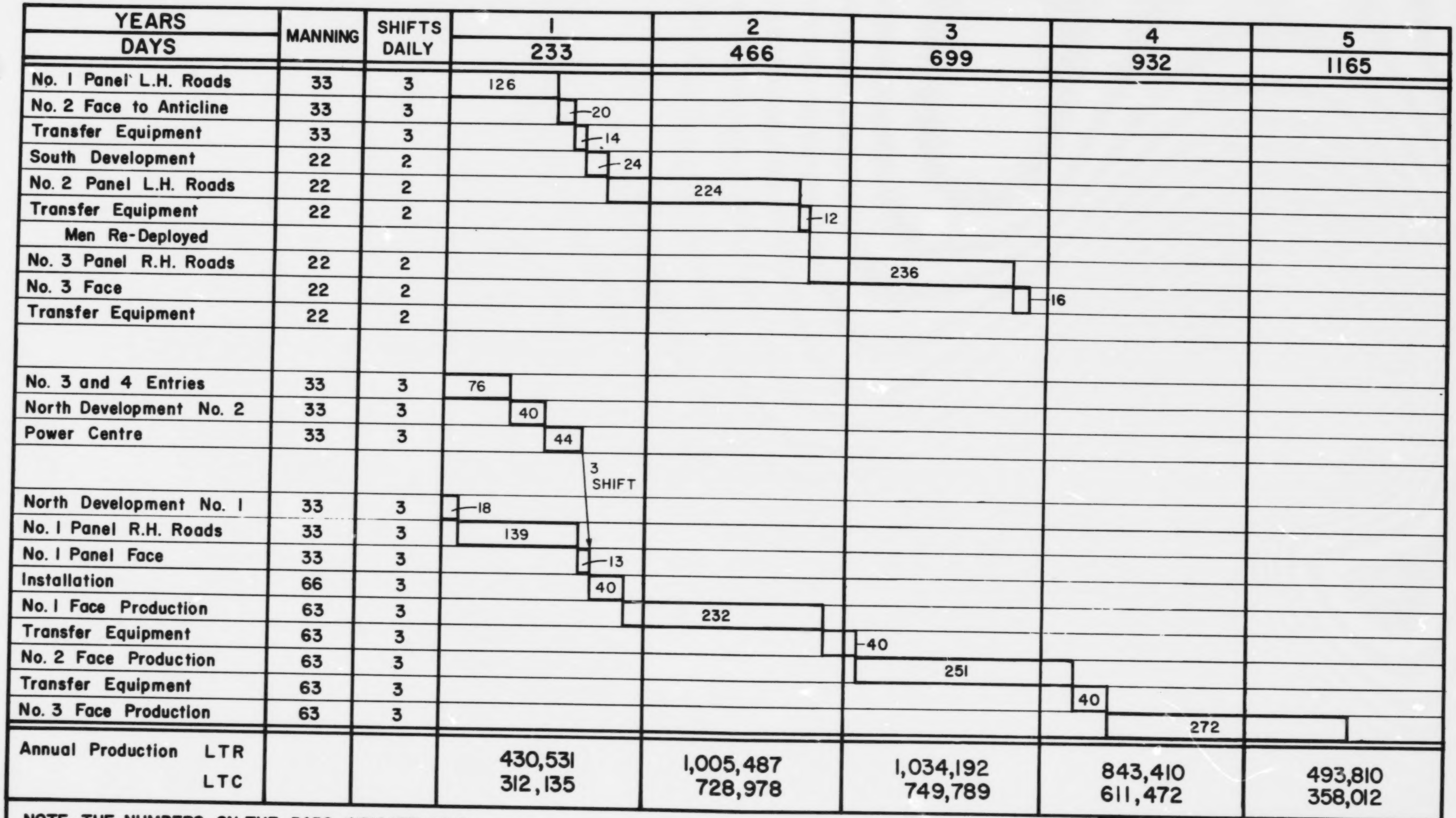
1. Conveyor in-road alongside face. i.e. road to rise side
2. Materials transport in roadway to dip side.
3. Operations: a) Cut 20' of advance witn JCM.
   b) Roof bolt 20'x16' on 4' square pattern.
   c) Side support and move up ventilation tubing.
   d) Move up conveyor and Stamler after crosscut completion.
   e) Move up exhaust fans at same time.

McINTYRE MINES

TYPICAL SEQUENCE
FOR
DEVELOPMENT OPERATIONS

NOV. 1982 FIG. 6-2

Scale: N.T.S.



YEARS	MANNING	SHIFTS DAILY	1	2	3	4	5
DAYS			233	466	699	932	1165
No. 1 Panel L.H. Roads	33	3	126				
No. 2 Face to Anticline	33	3	20				
Transfer Equipment	33	3	14				
South Development	22	2	24				
No. 2 Panel L.H. Roads	22	2		224			
Transfer Equipment	22	2		12			
Men Re-Deployed							
No. 3 Panel R.H. Roads	22	2			236		
No. 3 Face	22	2				16	
Transfer Equipment	22	2					
No. 3 and 4 Entries	33	3	76				
North Development No. 2	33	3	40				
Power Centre	33	3	44				
			3 SHIFT				
North Development No. 1	33	3	18				
No. 1 Panel R.H. Roads	33	3	139				
No. 1 Panel Face	33	3	13				
Installation	66	3	40				
No. 1 Face Production	63	3		232			
Transfer Equipment	63	3			40		
No. 2 Face Production	63	3			251		
Transfer Equipment	63	3				40	
No. 3 Face Production	63	3				272	
Annual Production LTR			430,531	1,005,487	1,034,192	843,410	493,810
LTC			312,135	728,978	749,789	611,472	358,012

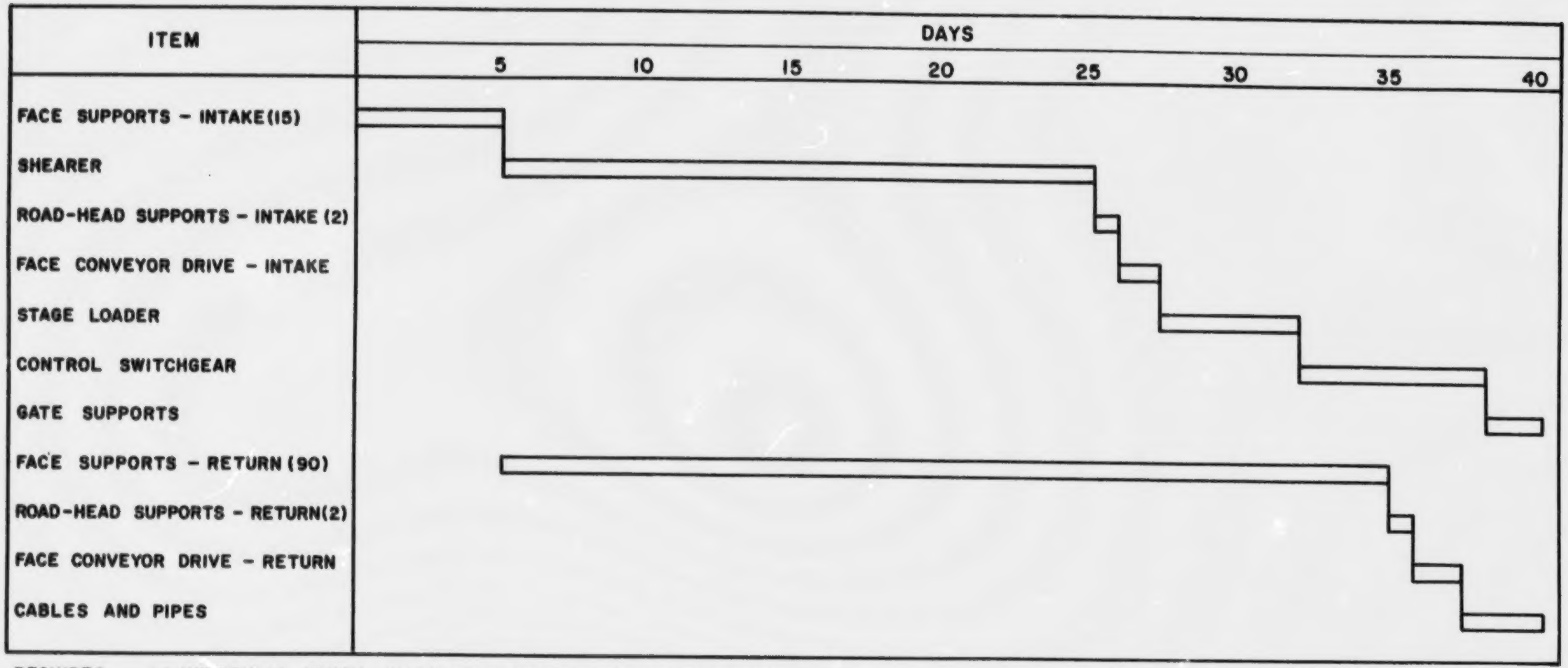
NOTE: THE NUMBERS ON THE BARS INDICATE DAYS.

McINTYRE MINES

DEVELOPMENT AND PRODUCTION
SCHEDULE
DEMONSTRATION PERIOD (5 YEAR)

NOV. 1982 FIG. 6-3

Scale: N.T.S.



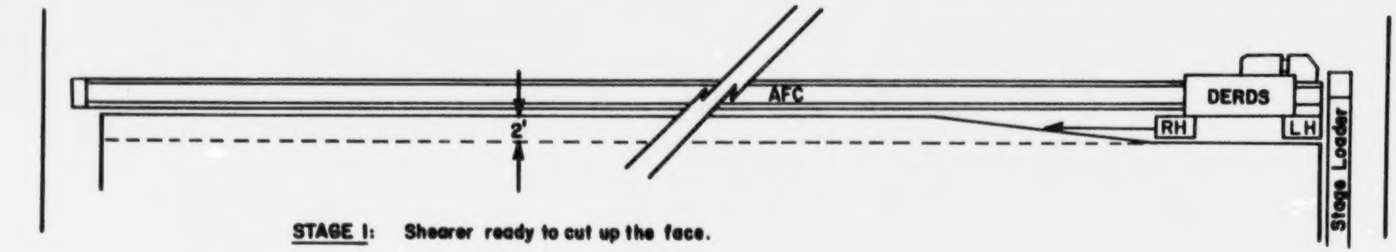
REQUIRES : 1/ HYDRAULIC POWER INSTALLED PRIOR TO FACE INSTALLATION
2/ INSTALLATION PROCEEDS ON CONTINUOUS BASIS

McINTYRE MINES

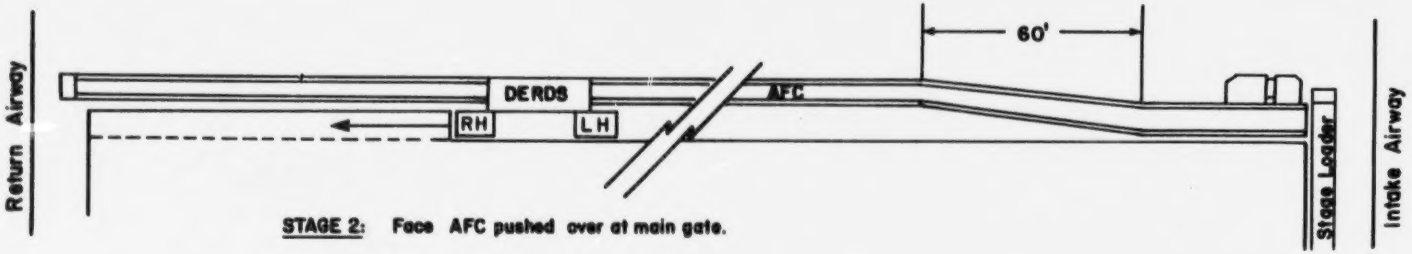
LONGWALL EQUIPMENT
INSTALLATION SCHEDULE

NOV. 1982

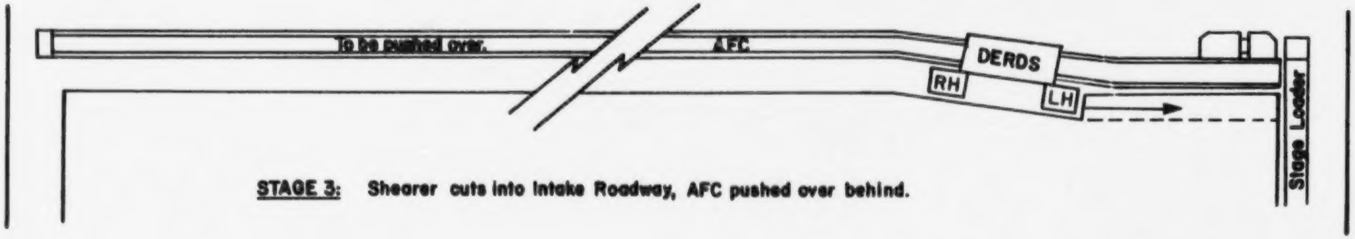
FIG. 6-4



STAGE 1: Shearer ready to cut up the face.



STAGE 2: Face AFC pushed over at main gate.



STAGE 3: Shearer cuts into Intake Roadway, AFC pushed over behind.

STAGE 4: As Stage I.

AFC: Armoured Face Conveyor
DERDS: Double Ended Ranging Drum Shearer

McINTYRE MINES

LONGWALL MINING
SEQUENCE OF OPERATIONS

NOV. 1982
FIG. 6-5
Scale: N.T.S.

McINTYRE MINES LIMITED

LONGWALL DEMONSTRATION
PHASE 1

SECTION 7 LONGWALL EQUIPMENT TENDERS

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7.0 LONGWALL EQUIPMENT TENDERS

7.1 INTRODUCTION

Section 7 discusses preparation of an invitation to tender for the supply of longwall equipment, and assessment of tenders received.

7.2 EQUIPMENT SPECIFICATION

A comprehensive site specific longwall equipment specification was prepared. This specification with relevant geological, geotechnical and other supporting data formed the basis for an enquiry document which was issued as an invitation to tender to selected manufacturers on August 11 1982 (Appendix 4-1). Suppliers were requested to submit tenders by 12 noon on September 21 1982.

To minimize risk, operating parameters and equipment performance levels were specified that can be readily achieved with the current generation of longwall mining systems.

Though conservative, this approach is believed prudent in view of the importance of a successful longwall demonstration. The advantages of this approach are numerous and include:

- The systems selected will employ technology proven at other mines.
- The systems can be critically previewed in operation at other mines.
- The operating experience gained at other mines can be assimilated before installation at Smoky River.
- Equipment malfunction should be minimal.

- The learning process normally associated with the application of new technology will be minimized.
- Since the equipment is being routinely manufactured, capital cost will be minimized.

7.3 ASSESSMENT OF TENDERS

7.3.1 Introduction

An invitation to tender for a longwall system and supporting services in accordance with the terms and conditions outlined in the enquiry document was issued to six manufacturers selected on their past record and reputation as suppliers of this type of equipment.

In response to the invitation five manufacturers submitted detailed and comprehensive tender documents. The sixth manufacturer formally declined the invitation to tender.

No single tender fully addressed the parameters outlined in the enquiry document. A number of items such as electrical equipment, gate conveyor, chock transportation systems, etc. were addressed in varying degrees of detail and several tenderers offered a multiple choice of support, shearer and conveying equipment (Table 7-1).

As a result direct comparison of tenders is not possible but each tenderer provided sufficient detailed information to form a sound basis for negotiation if a decision to proceed with the longwall installation is made. Tenderers are to be congratulated on the timely presentation of such comprehensive and detailed tenders.

7.3.2 Technical Assessment

To maintain commercial confidentiality each tender has been assigned a discrete identification letter from A to E. The key to the suppliers identity will be provided to CANMET under confidential cover. A comparison of the various items offered are contained in Tables 7-2 to 7-8.

In McIntyre's view the most important element in the tenders is the roof support system. The correct choice of support will determine the success or failure of the project. Each tenderer fully addressed this subject and provided detailed submissions for both longwall and roadhead supports.

The enquiry document required face supports to be capable of operating at gradients of up to 25°, transportation through roadways of limited height and operating on a relatively soft floor.

Assessment of the support specifications provided show that the support offered by supplier D did not meet the requirement for inclined seam operation and had a higher floor pressure than other systems. The support offered by supplier E did not meet the requirement for inclined seam operation and had a closed height of 7.6 ft. This would require that the support be dismantled for in-mine transportation.

For these reasons the face supports offered by suppliers D and E are considered to be the least suitable for application at Smoky River.

The supports offered by suppliers A, B and C adequately meet the required specification.

It was noted that the supports offered by supplier B had the highest total load capability and were lighter than either A or C. A reduced total weight for the support would be advantageous during transportation to the face and at face change time. However this is not considered sufficient reason on which to base the final selection and all three systems should be evaluated further following a decision to proceed with the longwall installation.

Before a final selection can be made each tenderer should, following technical discussions to define more closely the scope of the tender document, be invited to submit an amended tender which would allow a comparative evaluation to be made. Following the tender discussions and prior to receipt of the amended tenders the opportunity should be taken to visit longwalls at locations where equipment of similar design to that proposed for use at Smoky River is operating.

7.3.3 Assessment of Capital Cost

As several areas specified in the enquiry document were addressed in varying degrees of detail and alternative equipment proposed in many instances, possible combinations of costs made it extremely difficult to arrive at a total for a system which fully met the requirements of the enquiry document.

To arrive at a total cost for a system which complied with the enquiry document, a composite cost for the system was assessed as $12.5 million using cost data supplied by tenderers.

TABLE 7-1

TENDER COMPARISON SUMMARY

ITEM	SUPPLIER A	SUPPLIER B	SUPPLIER C	SUPPLIER D	SUPPLIER E
SHEARER					
a) Machine	2 types	1 type	3 types	3 types	1 type
b) Haulage System	2 systems	1 system	3 systems	3 systems	2 systems
c) Lump Breaker	1 type	1 type	1 type	1 type	1 type
POWERED SUPPORTS					
a) Type	1 type (4 leg chock shield)	2 types (4 leg shield & chock)	3 types (2 leg shields)	2 types (2 leg & 4 leg shield)	1 type (4 leg shield)
b) Extras	Forepole & face sprag	Forepole & face sprag	Forepole & face sprag	Forepole & face sprag	Forepole & face sprag
c) Control Equipment	Single adjacent	Bi-di adjacent	N.S.	Single adjacent	Bi-di adjacent
d) Power Pack	1 type	1 type	1 type	1 type	1 type
FACE CONVEYOR (AFC)					
a) Type	1 type	1 type	2 types	1 type	1 type
b) Ancilliaries	Full range	Full range	Full range	Full range	Full range
STAGE LOADER					
a) Type	2 types	1 type	2 types	1 type	2 types
b) Lump Breaker	1 type	1 type	1 type	1 type	2 types
c) Belt Conveyor R.E.	1 type	1 type	1 type	1 type	Crawler mounted
BELT CONVEYING SYSTEM					
a) Type	Drive, auto loop take-up	Drive, auto loop take-up	N.S.	Drive, R.E., Storage unit	1 type - Rigid Structure
EQUIPMENT TRANSPORTER	Manufacturer reference provided	Not stated	1 type	Railed transport system	1 type - MSHA approval
ELECTRICAL EQUIPMENT	Switchgear and cables	Complete system & data transmission	Complete system & data transmission	3 systems	N.S.
TRAINING PROGRAM	Consultant reference provided	Training program	N.S.	Site training program	Not detailed - cost quoted
EQUIPMENT COST (TYPICAL)	12,119,936.00 C.I.F. Mine Site	12,030,985.00 C.I.F. Sidney N.S.	12,156,000.00 F.O.B. Mine Site N.B. Cost Selected From Multiple Alternatives	12,088,000.00 F.O.B. Mine Site N.B. Cost from Multiple Alternatives	11,507,240.00 F.O.B. Port of Lading

TABLE 7-2

LONGWALL FACE EQUIPMENT SPECIFICATION SUMMARY

ITEM	SUPPLIER A		SUPPLIER B		SUPPLIER C			SUPPLIER D			SUPPLIER E	
Shearer: Make	A.S.	B.J.D.	A.S.		A.S.	Eichoff	Mitsui	A.S.	Eichoff	Mitsui	Mitsui	
Power H.P.	500	460	500		500	467	400	500	467	400	400	
Haulage Speed fpm	22	0-15	22		22	28	28	22	28	28	28	
Haulage System	Roll rack	Multi-drive	Roll rack		Rollrack	Eicotrack	Pinrack	Rollrack	Eicotrack	Pinrack	Pinrack (or Eicotrack)	
Drum Spec	66"PFF-HSV	66"PFF-HSV	66" PFF-HSV		66"PFF-HSV	78"PFF-HSV	72"HSV-PFF	66"HSV-PFF	78"HSV-PFF	72"HSV-PFF	72" HSV-PFF	
Supports: Type	Chock Shield		Chock Shield	Shield	Shield	Shield	Shield	Shield	Shield		Shield	
Total load legs - tons	4 - 600		4 - 650	4 - 650	2 - 500	2 - 500	2 - 500	2 - 575	4 - 575		4 - 550	
Range: Max. ins.	168		150	150	149	149	149	150	150		149	
Min. ins.	80		71	71	68	68	68	72	72		90	
Weight tons	20		14	14	22	22	22	17.5	17.5		14	
Gradient (max.)	30°		35°	35°	30°	30°	30°	N.S.	N.S.		Flat to Medium Inclined	
Floor Pressure at Yield psi	330		363	363	306	306	215	435	353		277	
Roof Pressure at Yield psi	180		197	197	126	126	125	168	129		200	
Control Valves	Adjacent - Unidi		Adj. Bidi	Adj. - Bidi	N.S.	N.S.	N.S.	Adj. - Unidi	Adj. - Unidi		Adjacent - Bidi	
Position of Support	Conventional - 1 Web back		Conventional	Conventional	1 web back	1 web back	Conven. or 1 web	Conventional	Conventional		Conventional or 1 web back	
Base Lifting Facility	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes		N.S.	
Feature			Capsule set extension	Wedge set extension	Split base	Solid base	Solid base					
Face Conveyor: (Profile)	Sigma		Sigma		Sigma		Sigma	Sigma			Box	
Line Pan height ins.	10.5		10.5		9.08		9.5	10.39			10.6	
width ins.	38.6		38.6		30.7		33	34.13			31.5	
Chain size and type	26 mm outboard		26 mm outboard		26 mm inboard		26 mm inboard	30 mm inboard			26 mm inboard	
Speed	208		210		213		258	224			217	
Capacity tph	1000		1000		1000		1000	1000			1000	
Stage Loader: (Profile)	Sigma		Sigma		Sigma		Sigma	Sigma			Sigma	Sigma
Line Pan Height ins.	10.8		10.5		9.08		9.5	10.39			8.75	8.1
Width ins.	38.6		38.6		30.7		33	34.13			30	31.5
Chain size and type	26 mm		26 mm O.B.		26 mm I.B.		26 mm I.B.	30 mm I.B.			26 mm O.B.	26 mm I.B.
Speed	258		243		256		303	260			280	236
Capacity tph	1200		1280		1200		1250	1500			1620	1100

* N.S. Not Stated   PFF Pick Face Flushing   HSV Hollow Shaft Ventilation   OB Outboard   IB Inboard

TABLE 7-3

SHEARER SPECIFICATION SUMMARY

MAKE		ANDERSON STRATHCLYDE AM 500	EICHOFF EDW 300 L	B.J.D.	MITSUI MCLE 350 - DR 6565 M
Offered by		Suppliers A, B, C, & D	Suppliers C & D	Supplier B	Suppliers C, D & E
Power	H.P.	500	467	500	400
Haulage Speed Max.	fpm	22	28	15	28
Haulage System		Roll rack	Multi-drive	Eicotrack	Pinrack or Eicotrack
Drum size	ins.	66	78	66	72
Drum R.P.M.		25	27	23	27
Facilities		HSY - PFF	HSV - PFF	HSV - PFF	HSV - PFF
Methane Detector		Yes	N.S.	N.S.	N.S.
Prestart Warning		Water Coalflow	N.S.	Visible & Audible Available	N.S.

HSV Hollow Shaft Ventilation
PFF Pick Face Flushing
N.S Not Supplied

TABLE 7-4

SUPPORT SPECIFICATION SUMMARY

ITEM		SUPPLIER A	SUPPLIER B	SUPPLIER C	SUPPLIER D	SUPPLIER E
Type:		Chock Shield	Chock Shield	Shield	Shield	Shield
Load	(tons)	4 - 600	4 - 640	2 - 500	4 - 575	4 - 550
Height: Open	(ft)	14'	12' 6"	12' 6"	12' 6"	12" 5"
Closed	(ft)	6' 8"	5' 11"	5' 10"	5' 11"	7' 6"
Weight	(tons)	20	14	22		14
Control		Unidi - adjacent	Bidi - adjacent	-	Unidi - adjacent	Bidi adjacent available
Pressure	(psi)	4500 - 5612	4500 - 5812	4785 - 6090	4640 - 6100	4267 - 5007
Centres	(ins)	59	59	59	59	59
Support Density						
Before Cut	(psi)	154.5	166.4	158.6	171	99.6
After Cut	(psi)	131.5	140.0	126.0	141.5	200
Roof Bearing Yield	(psi)	180	197.6	125	129	200
Floor Bearing Yield	(psi)	330	363.2	215	353	277
Gradient	(max)	30°	35°	30°	Not quoted	Medium Inclined to Flat
Base						
Type		Rigid	Rigid	Solid	Catamaran	Rigid
Base Lifting		Yes	Yes	Yes	Yes	No Mention
Area	(ft^2)	29.5	27.4	36.3	23.6	30.9
Canopy						
Type		Rigid	Rigid	Articulated	Rigid	Rigid
Area	(ft^2)	53.9	50.4	44.6	45.5	42.8
Forepole max.	(tons)	15	15	20	16.8	15
Face Sprag max.	(tons)	4.5	6	9.3	4.4	7.4
Positive Set		Yes	Yes	Yes	Yes	Not Mentioned
Walkway		Offered	Offered	No	No	Not Mentioned
Anticreep		Yes	Yes	Yes	Yes	Not Mentioned
Legs		D.A. D.T.	D.A. D.T.	D.A. D.T.	D.A. D.T.	D.A. S.T.
Position:		Conventional or 1 Web back	Conventional	Conventional or 1 Web back	Conventional	Conventional or 1 Web back
Transport		Eimco 936 Diesel	No Offer	Wagner Diesel Scooptram and Philips Trailer	Beco Railer (Face only)	Eimco 936 Diesel

* DA - Double Acting
DT - Double Telescopic

TABLE 7-5

HYDRAULIC POWER SUPPLY SYSTEM SPECIFICATION SUMMARY

ITEM	SUPPLIER A	SUPPLIER B	SUPPLIER C	SUPPLIER D	SUPPLIER E
Make	Hauhinco	Gullick	Hauhinco	Hauhinco	Hauhinco
Pumps	3 of EHP 3K-60-40	2 of S 15	2 EHP 3K 90/45	3 of EHP 3K 110/45	3 of K90/110/45
Output (gpm)	22	42	42	42 per pump	42 per pump
Pressure (psi)	4500	4500	4500	4500	4500
H.P.	90 x 3	150 x 2	125 x 2	150 x 3	150 x 3
Emulsion Tank (galls)	200 x 2		220 x 2	265	581.2 (U.S.) 3 of
Oil Tank (galls)		450 1 of			26.4 (U.S.) 3 of
Surge Tank (galls)				220	132.1 (U.S.) 3 of
High Pressure	5,000' Steel	5,000' Steel	5,000 x 1.5" dia. Steel	5,000 Steel	5,000' Steel
Return Pipe	5,000' Steel	5,000' Steel	5,000 x 2" Water Pipe	5,000 Plastic	5,000'
Dust Suppression Tank (gal)		2 of 5150 450			

TABLE 7-6

FACE CONVEYOR SPECIFICATION SUMMARY

ITEM	SUPPLIER A	SUPPLIER B	SUPPLIER C	SUPPLIER D	SUPPLIER E
Type		A.S. Dreadnought 1500	American Longwall	UFv 34/700	MCCv - HB800
Profile	Sigma	Sigma	Sigma	Sigma §	Box
Pan Height (ins)	10.5 (268 mm)	10.5	9 1/2" (240 mm)	10.39" (264 mm)	10.6" (270 mm)
Pan Width (ins)	38.6	38.6	33" (834 mm)	34.13	31.5"
Conveyor Length (ft)	563	*578	571 ft	571 ft	542.7 ft
Deck Plate (ins)	1.18	1.2	1.25 ins	1.18 ins	2 x 0.625 ins.
Chain Speed (fpm)	208	210	258 fpm	224 fpm	217 fpm
Chain Size & Grade	26 mm (Din 22252)	26 mm (Din 22252)	26 mm (Din 22252)	30 mm	26 mm (C)
Capacity (tph)	1360	1000	1000	1000 tons per hour	1000 tons per hour
Motors: Main Drive HP	300	300	400	300	300
Tail Drive HP	300	300	400	300	200
Chain Assembly	Outboard	Outboard	Inboard	Inboard	Inboard
Bottom Covered	Covered	Covered	Covered	Hinged 5th pan Welded others	Boxed
Furnishings	Complete	Complete	Complete	Complete	Complete
Cable Handler	Bretby (Iron)	Bretby	Bretby	Bretby Mark II	
Spill Plate Height (ins)	40"	60"	30 3/4"	40.15"	39 3/8"

TABLE 7-7

STAGE LOADER AND BREAKER SPECIFICATION SUMMARY

ITEM		SUPPLIER A	SUPPLIER B	SUPPLIER C	SUPPLIER D	SUPPLIER E
STAGE LOADER						
Make		Dowty Meco	Anderson Strathclyde	American Longwall	UFv 34 1700	MCCv - H800
Profile		Sigma	Sigma	Sigma	Sigma	Sigma
Pan Height	(ins)	10.55	10.5	9 1/2	10.39 ins	8.1" (206 mm)
Pan Width	(ins)	38.6	38.6	33	34.13 ins	31.5" (800 mm)
Conveyor Length	(ft)	69	131	75	76 ft	70.5 ft
Overlap	(ft)	3.28	23		18 ft	varies
Chain Speed	(fpm)	258	243		260 fpm	236 fpm
Capacity	(rph)	1360	1280	1250	1500 tons per hr.	1100 tons per hr.
Chain Configuration		Outboard	Outboard	Inboard	Inboard	Inboard
Motor	(hp)	150	150	150		
BREAKER			Klockner Becorit 5B63		SB 160V	Crockett
Type		Impact	Impact	Vertical Drum	Impact	Vertical Drum
Motor	(hp)		150	150	2 x 100	2 x 120
Capacity			1200	1000 - 2000	1800 tons per hr.	1500 tons per hr.
Deckplate		3"	2 1/2"	3"		

TABLE 7-8

ROADWAY CONVEYOR SPECIFICATION SUMMARY

ITEM		SUPPLIER A	SUPPLIER B	SUPPLIER C	SUPPLIER D	SUPPLIER E
Make		Dowty-Meco	Anderson Strathclyde	No drive or loop included in the quotation	Long Airdox Lo Rope	Long Airdox Lo Rope
Head End Pulley	(ins)	16			36	36
Drive head		150 BL			DT 36 H	DT 36 H
Motor	(hp)	150	2 x 350		2 x 350	2 x 350
Capacity	(tph)		1200		1200	1200
Loop Length	(ft)	80	Auto		Super 500 H.D.	Super 500 H.D.
Storage	(ft)				500	500
Belt Reeling		Yes (extra)	No	No	No	No
Return End		In Stage Loader Spec	Mobile (Included in S.L.)	Included in Stage Loader 42-HA-15-LV	Return Crawler Mounted	Return Crawler Mounted
Belt Width	(ins)	48	42	42	42	42
Belt Speed	(fpm)	600				600

McINTYRE MINES LIMITED

LONGWALL DEMONSTRATION
PHASE 1

SECTION 8 MANAGEMENT OF A LONGWALL DEMONSTRATION PROJECT

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Figure 8-1 Proposed Project Management Structure

8.0 MANAGEMENT OF A LONGWALL DEMONSTRATION PROJECT

8.1 INTRODUCTION

Section 8 discusses management and control of the longwall demonstration project, identifying terms of reference for the Project Steering Committee, recommendations for research and the need for training of supervisory and operating personnel.

8.2 PROJECT MANAGEMENT

8.2.1 Introduction

The management and control of a longwall demonstration project will be complex and challenging.

It is likely that the only suitable location for a longwall demonstration would be within an existing mine, in order to take advantage of available expertise and a market for the coal.

Consequently, since longwall produces large volumes of coal (approximately 1 million raw tons per annum from one unit and associated development) it could provide a substantial proportion of the total output at the mine.

Additionally it must be understood that mining legislation assigns responsibility for matters relating to safety to designated members of line management, and that their ability to ensure compliance with the relevant statutes cannot be compromised.

The major objectives of the demonstration project are to show that in Rocky Mountain conditions:

- Longwall provides a safer working environment than conventional room and pillar.
- Reserves not presently recoverable by room and pillar can be mined by longwall.
- Longwall is economically viable.

A demonstration will provide a unique opportunity to:

- Initiate and conduct meaningful mining research programs.
- Collect and disseminate data related to the mining operation.
- Afford an opportunity to provide "hands on" training in all areas related to longwall mining operations.

The project management team must maximize the benefit to be obtained from this opportunity.

8.2.2 ORGANIZATION

It must be recognized at the outset that at times certain aspects of research programs may conflict with operational requirements and that when this occurs a rapid and equitable solution must be obtained. Research requirements during normal operations must be scheduled to ensure they do not adversely affect operational safety or the potential for continuity of production.

It is therefore of paramount importance to ensure that persons employed on the project management team to control operations and research are fully conversant with longwall mining operations, suitably experienced and qualified.

To control the project a small team of competent engineers and technicians with clearly defined responsibilities and lines of communication is to be preferred to a committee since decisions which may affect the operational and research aspects of the project will be required on a day to day basis.

To guide the project team and monitor performance of the operation and research aspects of the project, a steering committee should be formed. Membership on this committee should be limited to those with a direct interest and involvement in the project and the committee should function under the chairmanship of a CANMET designated officer.

The steering committee should be formed as soon as practicable after the decision to proceed with the project has been made and should meet at regular intervals throughout the project life. A monthly meeting schedule is proposed for the initial stages and 2-month intervals would be appropriate during the longwall operating stages.

A proposed project management structure is shown in Figure 8-1. A proposed Project Steering Committee structure and terms of reference are shown on Table 8-1.

8.2.3 Project Team Function

The project management structure shown in Figure 8-1 envisages that a Project Manager Research will be appointed by CANMET to supervise and direct the research programs. The Project Manager Research will liase directly with the Manager Underground Mines to ensure that research projects are accorded the appropriate priority and will report directly to the steering committee.

The Manager Underground Mines will ensure that mining is conducted in accordance with all relevant mining statutes and that production objectives are achieved.

It is anticipated that both the Manager Underground Mines and Project Manager Research would organize and structure regular meetings to assist in control and coordination of the total project.

The Vice President/General Manager would provide overall supervision of the mining and research activities and act to priorize activities in the event of disagreement without compromising operational safety and compliance with mining statutes.

Normally the Manager Underground Mines and Project Manager Research would provide regular reports to the steering committee. The Vice President/General Manager would attend committee meetings upon request.

8.3 RECOMMENDATIONS FOR RESEARCH

The development and operation of a longwall mining system at Smoky River presents a unique opportunity to conduct research under controlled conditions. The following list identifies some of the areas where such research may be undertaken:

- Rapid drivage in inclined seams by either multiple or single entry systems.
- Convergence studies in roadways and pillars adjacent to longwall operations.
- Subsidence studies at the surface to derive meaningful parameters for Rocky Mountain conditions.
- Application of remote monitoring systems for environmental control and determination of the relationship between production and methane liberation.
- Alternative dust suppression techniques for both development and longwall systems.
- Application of high frequency strata monitoring devices to predict roof falls.
- Application of remote monitoring systems to provide management information on system performance.
- Application of methane drainage systems to reduce methane concentrations adjacent to longwall operations.
- Alternative roadway support techniques.
- The effect of improved illumination on operational performance and worker morale both in development drivage and longwall operations.
- Remote control of mining machines for longwall and development.
- Assessment of performance of support systems on the longwall and in roadways.
- Assessment of strata behaviour related to stress and pressure developed during longwall mining.

The variations in Panels #1 to #3 in relation to cover, gradient and geological disturbance are such that these factor related events could be identified within 4 years.

8.4 TRAINING

8.4.1 Introduction

To obtain maximum benefit from the installation of longwall mining systems it is important to ensure that supervisory, maintenance and operating personnel are properly trained.

The objective of the training program is to ensure that every person employed on the longwall mining operation is fully conversant with:

- The objectives of the project and the personal contribution required.
- The mining systems and the inter-relationship of each mining activity.
- The operating and safety characteristics of each item of equipment used.
- The methods of operation and control for each item of equipment used.

8.4.2 Timing

Development and implementation of proper training programs requires a significiant period of time. Based upon the schedules for development and an assessment of quotations received, at least six months will elapse between placing of an order and equipment delivery. Provided that training program development is initiated at the time of placement of order no undue difficulty should be experienced.

8.4.3 Program Development

The training program must encompass the needs of all the various skills necessary to operate the longwall system and can be subdivided into three discrete sections:

- Mining Supervisory Skills.
- Operator Skills.
- Maintenance Skills.

As the basis for program development a job description for each activity must be developed and the skill and experience level of the existing workforce determined. Typical job descriptions are shown in Tables 8-2 to 8-9.

8.4.4 Program Delivery

To take advantage of the available time and maximize training opportunities the program could be delivered in a phased manner:

- Phase 1: Visits to operating longwall installations with similar mining conditions and equipment.
- Phase 2: Following equipment delivery, conduct equipment familiarization and site specific training. This would be undertaken at the minesite and utilize selected sections of the actual equipment to be used erected at site for training purposes.
- Phase 3: Training during installation and early operation of the longwall.

An outline of a longwall training program and estimated cost for program implementation has been provided by Associated Mining Consultants Ltd. (Appendix 4-3).

A valuable benefit from a longwall demonstration is the opportunity to provide a 'hands on' training environment for the planning and operation of longwall systems to other interested coal mine operators. This would be of particular benefit to potential operators and greatly assist in the dissemination of longwall mining technology.

TABLE 8-1

PROPOSED STRUCTURE AND TERMS OF REFERENCE
PROJECT STEERING COMMITTEE

Chairman - CANMET Representative

Members - Department of Occupational Health and Safety
- Energy Resources Conservation Board
- Department of Energy, Mines & Natural Resources
- Coal Mining Research Council
- Coal Association of Canada, Research & Development
- Vice President, Smoky River Coal Limited

Ex Officios - Project Manager Research, CANMET
- Manager Underground Mines, Smoky River Coal Limited

Terms of Reference

1. Monitor the progress of the longwall trial.
2. Provide periodic and final assessment of the project.
3. Collate and disseminate information on the project.
4. Approve and co-ordinate additional on-site research.

TABLE 8-2

McINTYRE MINES

No. 9G-4 Mine Smoky River

JOB TITLE: Machine Operator

JOB SPECIFICATION: Shearing Machine Operation

LOCATION: Throughout Face Length

DUTY:

1. Obtain planned performance for each shift.
2. Visually check the shearer, in particular oil level, safety equipment and cables, prior to beginning work.
3. Operate the shearer to give the required advance per shift.
4. Check the cutting horizon and report any abnormalities to the Fireboss.
5. When approaching the Face Ends ensure that all obstructions are cleared and that all personnel retreat to a safe position.
6. Ensure that all ancillary equipment on the machine is functioning correctly at all times.
7. Report any obvious defects on the machine to the Fireboss and Mechanic or Electrician.
8. Report the machine position to the Stage Loader Operator when required.
9. Upon instruction of the officials undertake any work required to ensure the safe and efficient running of the District.
10. Maintain safe working conditions.

ACCOUNTABILITY:

Responsible to the Fireboss for completion of tasks.

Responsible to the Fireboss for work standards and safety.

"As a member of the Face Team, carry out any other duties at the direction of the responsible officials".

TABLE 8-3

McINTYRE MINES

No. 9G-4 Mine Smoky River

JOB TITLE:	Support Operator
JOB SPECIFICATION:	Advance of Supports and Conveyor
LOCATION:	Throughout Face Length

DUTY:

1. Obtain planned performance for each shift.
2. Fully advance and grade the conveyor in accordance with the requirement of the mining system.
3. Advance supports as required to provide maximum web depth for each shear and control face alignment.
4. Ensure that the roof is properly and safely supported at all times.
5. Ensure that all hoses and cables are kept in correct position.
6. Clean out support bases to ensure a good travelling road.
7. Assist with support repairs as and when necessary.
8. Report any defects in the support system to the responsible official.
9. Before undertaking any work on the face side of the conveyor ensure that temporary supports are set in accordance with the Manager's support rules.
10. Maintain safe working conditions.

ACCOUNTABILITY:

Responsible to the Fireboss for completion of tasks.

Responsible to the Fireboss for work standards and safety.

"As a member of the Face Team carry out any other duties at the direction of the responsible official".

TABLE 8-4

McINTYRE MINES

No. 9G-4 Mine Smoky River

JOB TITLE: Face End Operator

JOB SPECIFICATION: Face End Operations

LOCATION: Intake and Return Road Heads

DUTY:

1. Ensure that cables are clear when advancing the AFC Drive Units.
2. Ensure that all ancillary equipment used for the advancement of the drive units, is in safe working order.
3. Ensure that all supports are set in accordance with the Manager's Support Rules.
4. Ensure that all transfer deliveries are centralized.
5. Report any defects in the equipment to the official in charge and the Maintenance Team.
6. Maintain safe working conditions.

ACCOUNTABILITY:

Responsible to the Fireboss for completion of tasks.

Responsible to the Fireboss for work standards and safety.

"As a member of the Face Team, carry out any other duties at the direction of the responsible official".

TABLE 8-5

McINTYRE MINES

No. 9G-4 Mine Smoky River

JOB TITLE:	Stage Loader Operator (Switch Man)
JOB SPECIFICATION:	Conveyor and Communication Control
LOCATION:	Main Gate

DUTY:

1. Check and test stage loader for "trouble free" running at start of shift.
2. Check all switchgear for correct operation.
3. Maintain communications between face, officials, Management and the Control Room.
4. Regularly inform the Control Room of the production status of the operation.
5. Clean up spillage at transfer point, stage loader on to gate conveyor.
6. Report immediately any abnormalities in switchgear and/or conveyors to the responsible official or tradesman.
7. Ensure that cables are clear from obstructions etc.
9. Maintain safe working conditions.

ACCOUNTABILITY:

Responsible to the Fireboss for safe working of the apparatus.

Responsible to the Fireboss for work standards.

TABLE 8-6

McINTYRE MINES

No. 9G-4 Mine Smoky River

JOB TITLE: Chock Maintenance

JOB SPECIFICATION: Maintenance of Roof Supports

LOCATION: Throughout Face Length

DUTY:

1. Maintain the support installation in good and efficient working condition.

2. Report and remedy any defects in the support installation.

3. At the commencement of the shift, check the power pack to ensure:

   (i) The suction and feed line filters are clean. Replace filter elements as required.
   (ii) The soluble oil content of the solution is satisfactory.
   (iii) The level of solution in the tank is satisfactory.

4. At the shift end reoort to the Fireboss on any repairs carried out and any outstanding requirements or defects.

5. As required by the Manager's Scheme of Maintenance conduct the specified periodic checks and examinations.

6. Carry out any work required to ensure the safe and efficient running of the district upon the instruction of the face officials and the Engineering staff.

7. Maintain safe working conditions.

ACCOUNTABILITY:

Responsible to the Senior Fireboss and Fireboss for completion of tasks.

Responsible to the Fireboss for work standards.

"As a member of the Face Team, carry out any other duties at the direction of the responsible official".

TABLE 8-7

McINTYRE MINES

No. 9G-4 Mine Smoky River

JOB TITLE:	Mechanic
JOB SPECIFICATION:	Mechanical Maintenance
LOCATION:	Whole District

DUTY:

1. Comply with the statutory requirements of relevant acts and regulations.
2. Service and maintain all mechanical equipment in safe and efficient working order to achieve planned face performance.
3. Ensure that equipment is available for examination and testing to comply with the Manager's Scheme of Maintenance.
4. Conduct periodic examinations and tests in accordance with the requirements of the Manager's Scheme of Maintenance.
5. Confer with the Fireboss during the shift to ensure close co-operation in all matters relating to mechanical efficiency.
6. Report on the work done, defects remedied and defects that "require follow up".
7. Contribute ideas or suggestions for the improved efficiency of the district as a whole.
8. Maintain safe working conditions.

ACCOUNTABILITY:

Responsible to the Fireboss and Engineer for completion of tasks.

Responsible to the Engineer for work standards.

"As a member of the Face Team, to carry out any other duties at the direction of the responsible official".

TABLE 8-8

McINTYRE MINES

No. 9G-4 Mine Smoky River

JOB TITLE: Electrician

JOB SPECIFICATION: Electrical Maintenance

LOCATION: Whole District

DUTY:

1. Comply with the statutory requirements of relevant acts and regulations.
2. Service and maintain all electrical equipment in safe and efficient working order to achieve planned face performance.
3. Ensure that equipment is available for examination and testing to comply with the Manager's Scheme of Maintenance.
4. Conduct periodic examinations and tests in accordance with the requirements of the Manager's Scheme of Maintenance.
5. Confer with the Fireboss during the shift to ensure close co-operation in all matters relating to electrical efficiency.
6. Report on the work done, defects remedied and defects that "require follow up".
7. Contribute ideas or suggestions for the improved efficiency of the district as a whole.
8. Maintain safe working conditions.

ACCOUNTABILITY:

Responsible to the Fireboss and Engineer for completion of tasks.

Responsible to the Engineer for work standards.

"As a member of the Face Team, to carry out any other duties at the direction of the responsible official".

TABLE 8-9

McINTYRE MINES

No. 9G-4 Mine Smoky River

JOB TITLE: Fireboss

JOB SPECIFICATION: Supervisor and Safety of Operations

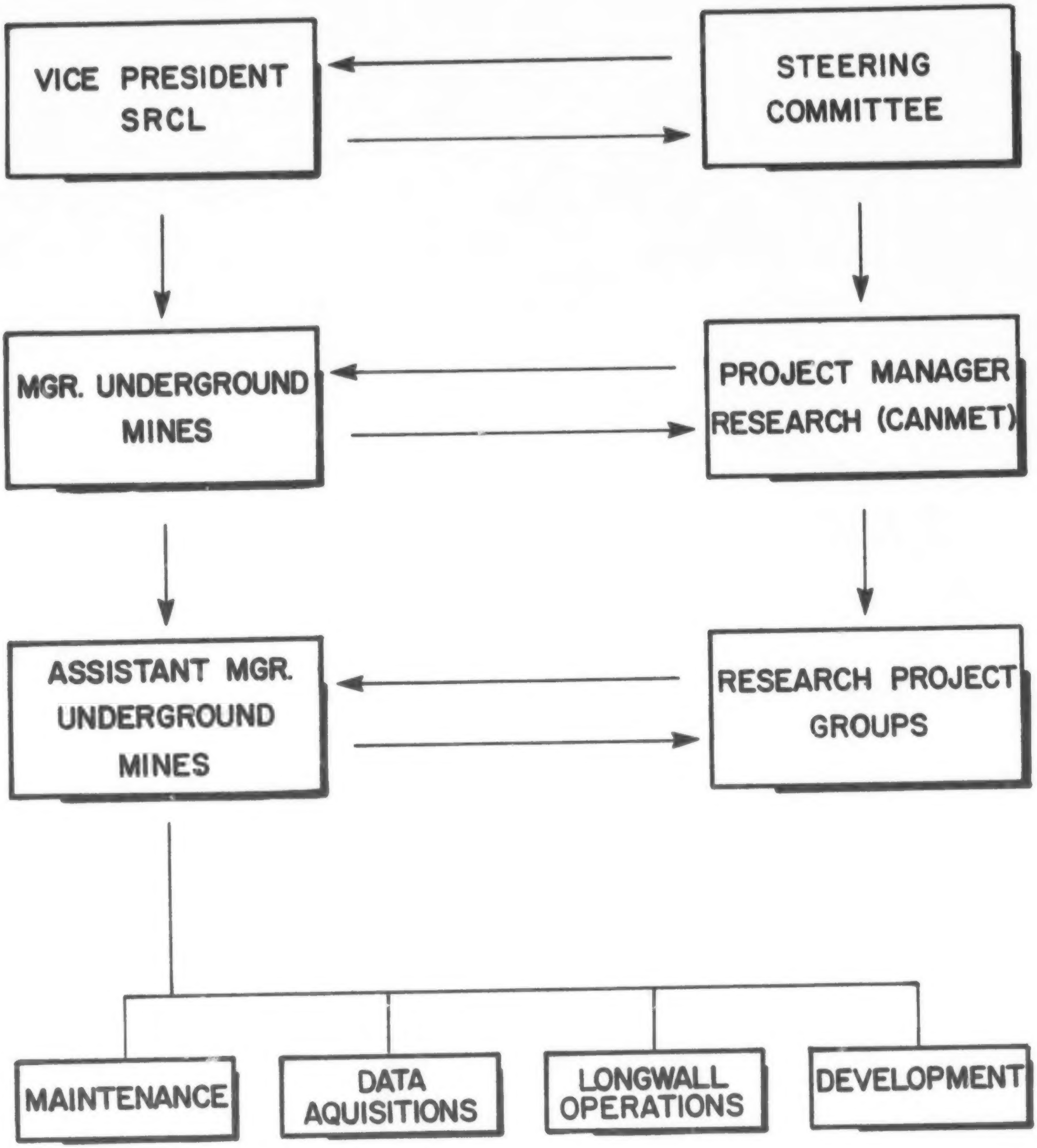
LOCATION: Whole District

DUTY:

1. Plan, organize and control all operations within the district and ensure that the planned performance is obtained in accordance with:
    - (i) Statutory requirements
    - (ii) Manager's Rules
    - (iii) Any additional instructions given by superiors
2. Check and countersign reports.
3. Carry out mid-shift and pre-shift inspections.
4. Control manpower deployment.
5. Control overtime to meet the budget.
6. Organize supplies of materials into the district.
7. Exercise daily control of mining operations.
8. Organize the transportation of damaged machinery, cables and salvaged items to the surface for repair and replacement.
9. Check on standards of work at all operations and report at the shift end to the senior official for the mine.
10. Submit a written report on the shift's progress.
11. Submit required statutory reports.

ACCOUNTABILITY:

Accountable to the Senior Fireboss and Assistant Manager for all operations and task performance of all personnel within the district.



McINTYRE MINES

PROPOSED PROJECT
MANAGEMENT STRUCTURE

NOV. 1982

FIG. 8-1

Scale: N.T.S.

McINTYRE MINES LIMITED

LONGWALL DEMONSTRATION
PHASE 1

SECTION 9 ECONOMIC EVALUATION

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9.0 ECONOMIC EVALUATION

9.1 INTRODUCTION

This section provides projections of mining costs and an economic evaluation of longwall mining at No. 9G-4 Mine. Detailed cost assessments are provided relating to the mining and delivery of coal to a stockpile on the surface near the portals, embracing all aspects of the longwall mining process including development, production, maintenance and supporting services.

The costs for longwall at No. 9G-4 Mine form a basis from which potential operators could develop cost estimates for longwalling at other locations.

Non-direct costs such as coal preparation, administration, rail and port and the sales revenues received for the coal that are specific to the Smoky River operation have been used in the economic evaluation. In order to assess the economics of longwall at other locations, potential operators would have to substitute their site specific values.

Several approaches can be adopted when evaluating longwall mining. For example, the longwall activity can be appraised in isolation or the total mining project, including infrastructure, major mine development and underground operations can be assessed. The approach adopted in this report lies between these two extremes, since the infrastructure is in place and major development has already been completed.

If the demonstration shows longwall mining to be viable then the equipment could be transferred to other panels within No. 9G-4 Mine adjacent to the demonstration area, for the remainder of its estimated 10 year useful life. Consequently, two project durations have been evaluated - a period of 5-years in which three demonstration panels would be worked and a 10-year period in which a total of 8 panels would be worked.

The costs and economic analyses are based upon:

- production rates shown in Table 6-2 column 3,
- manpower levels shown in Table 6-4 and
- development and production schedules shown in Figures 6-3 and 9-2.

Figure 9-1 shows the proposed mining layout for the extended operation.

9.2 CAPITAL COSTS

The capital already expended to access the reserves in the 9G-4 Mine is not included in the analysis performed. Only the capital costs directly related to the development for and the operation of the longwall are considered.

Where appropriate suitable equipment from within the existing pool at Smoky River has been allocated and charged to the project at 1/3 of its replacement capital cost. Capital costs also include additional equipment, replacement items, major overhauls and exploration.

The total capital expenditure required for the demonstration period is estimated to be $19.2 million (Table 9-1) and for the extended operation $26.2 million (Table 9-2).

A summary of capital expenditures is shown in (Table 9-3).

9.3 OPERATING COSTS

Operating costs are subdivided into three categories:

- Direct Mining Costs
- Non-Direct Costs
- Capital Charges and Regulatory Costs

9.3.1 Direct Mining Costs

These costs are associated with development, longwall mining and transportation of the coal to a mine-mouth stockpile. These costs include labour, mining materials, maintenance and power cost for both the development and longwall operation. The categories used at Smoky River are:

- Labour including supervision
- Electric power
- Mining materials
- Propane
- Maintenance; vehicle and mine.

Labour charges reflect negotiated contract rates and include all other charges associated with underground mining under this contract.

Development costs are based on actual costs incurred during recent activity at Smoky River. Where applicable, these costs have been derived as a standard cost for development and stated in dollars per raw ton.

For longwall, all costs other than mining materials have been derived from current operating data. Since mining material consumption data for longwall mining in Western Canada is not available, an estimate of \$2 per raw ton has been used. This figure is believed to be more than adequate when viewed against the costs incurred at other similar longwall operations.

General mine maintenance costs are based on actual costs incurred during development and operation of the No. 9G-4 Mine. This cost includes both daily maintenance and major rebuilds. Longwall maintenance costs have been estimated from manufacturer's recommended maintenance schedules.

A detailed analysis of total direct mining costs for the demonstration (Table 9-4) shows a cost of \$33.53 per raw ton at the mine-mouth in year 1, reducing to between \$11.64 and \$13.53 in years 2 through 5. This is due to the initial high ratio of development to longwall tonnage which is reversed as the project continues (Table 9-5). This results in a total operating cost of \$14.4 million for the first year's production of 431,000 raw tons with \$11.8 million attributed to development and \$2.6 million to longwall. A further \$4.7 million of expenditure will be incurred in years 2 and 3 for development. A cost of \$11.1 million per year will be associated with the longwall operations from years 2 to 4 reducing to \$5.7 million in the fifth year of the project.

For the extended operation, development work will continue each year. Initially three development teams will be deployed reducing to two teams for years 2 and 3. Three development teams will again be deployed in year 4 reducing to two teams for years 5 through 10.

Manpower levels in the extended operation are similar to those specified in the manpower deployment schedule for the demonstration period (Table 6-4) but with additional manpower to sustain development in years 4 to 10.

A detailed analysis of total direct mining costs for the extended operation (Table 9-6) shows a cost of $33.53 per raw ton at the mine-mouth in year 1 reducing to between $12.96 and $14.15 in years 2 through 10. The higher cost per raw ton in year 5 of the extended operation ($14.15) in comparison to the demonstration period ($11.64) reflects the increased development required to access the additional panels. The total operating cost for the first year's production of 431,000 raw tons is $14.4 million with $11.8 million attributed to development and $2.6 million to longwall operations. This will reduce to $13.3 million in years 5 through 10 with $2.6 million attributed to development and $10.7 million to longwall operations.

9.3.2 Non-Direct Costs

Non-direct costs are those costs associated with processing, transportation of the coal and administration. The costs which are unique to the Smoky River operation, have been provided to CANMET under confidential cover. These costs when added to the direct mining costs provide the basis for a complete analysis of the longwall operation and its effects on the economics of the Smoky River Mine.

9.3.3 Capital Charges and Regulatory Costs

These charges include depreciation, depletion, taxes and royalties and have been used for the calculations of pre-tax income provided to CANMET under separate cover.

9.4 CASH FLOW ANALYSIS

The estimated capital cost, direct and indirect operating costs and actual market price for Smoky River coal have been used to conduct a cash flow analysis for both the demonstration and extended operation periods. It was assumed that the capital expenditure required to procure the longwall equipment would be expended in the first year of operation with no special financial arrangements made.

These analyses show that apart from the first year of operation there is a positive cash flow in each succeeding year for both the demonstration and extended operation period.

The net present value of the cash flow during the demonstration period is satisfactory and is enhanced by the extended operation.

The effect of varying certain parameters on the net present value of cash flows has been assessed. This shows production level and coal sale price to be the most critical variables.

Detailed cash flow and sensitivity analyses have been provided to CANMET under separate cover.

9.5 PROCUREMENT FINANCING

Each tenderer suggested a method by which the longwall equipment capital cost could be financed to allow payment over an extended period.

The major benefit to be derived would be a reduction in the negative cash flow in the initial years of the project. Table 9-7 provides a summary of the alternative options offered.

9.6 RISK

The advanced status of the development of 9G-4 Mine and the configuration of the target reserve area reduces the overall risk associated with the investment in longwall. At a new mine, additional capital would be required to develop access to the reserve and the geology and geotechnical parameters of the reserve area would be less well known.

Should the longwall fail to achieve its projected production level Smoky River Coal Ltd. would face a substantial loss. However, if projected production levels can be consistently achieved, the financial risk should be limited and a reasonable rate of return on investment obtained.

9.7 CONCLUSIONS

Implementation of the longwall at Smoky River will displace other production capacity. The longwall must therefore achieve its planned production output levels throughout its life to ensure production commitments can be met.

While the risk associated with the project appears manageable, the project is unique to Western Canada and the total extent of the risk cannot be fully determined until a longwall mining system has been installed and operated.

McIntyre believe that the risk should be shared as the benefits to be gained from the longwall operation would be widespread and a unique opportunity to undertake meaningful research would be provided. The involvement of CANMET and other interested agencies to reduce the up-front capital required and the risk to the operator would enhance the potential for the implementation of a longwall demonstration project.

TABLE 9-1

CAPITAL COST DEMONSTRATION PERIOD (5-YEAR)

MAJOR PURCHASE SUMMARY

DESCRIPTION	REPLACEMENT VALUE (EACH)	NUMBER YEAR 1	REQUIRED YEAR 2-5	CAPITAL PER YEAR				
				YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
CONTINUOUS MINERS	650,000	4	2	430,000	430,000	430,000		
PROFILE HEADER MACHINES	750,000	0	1		750,000			
SHUTTLE CARS	125,000	6	4	167,000				
ROOF BOLTERS	120,000	6	4	167,000				
STAMLER FEEDERS	220,000	3	2	145,000				
AUXILIARY FANS	9,000	6	3			9,000		
PUMPS	5,000	3	3		5,000		5,000	
MATERIAL VEHICLES	240,000	3	3	240,00	160,000		160,000	
TRANSFORMERS	60,000	3	1	20,000				
SWITCHGEAR	14,000	26	8	37,000				
LIGHTENING TRANSFORMERS	7,000	2	1					
TELEPHONES	1,500	4	2					
HIGH TENSION SWITCHES	19,000	2	1	6,000				
CONVEYOR STRUCTURES & BELTS				827,000				
CONVEYOR DRIVES				100,000				
SUB TOTAL				2,152,000	1,345,000	439,000	165,000	
CONTINGENCY (15%)				323,000	202,000	66,000	25,000	
TOTAL CAPITAL DEVELOPMENT EQUIPMENT				2,475,000	1,547,000	505,000	190,000	
LONGWALL EQUIPMENT				12,500,000			2,000,000	
TOTAL CAPITAL				14,975,000	1,547,000	505,000	2,190,000	

TABLE 9-2

CAPITAL COSTS EXTENDED OPERATIONS (10-YEAR)

MAJOR PURCHASE SUMMARY

DESCRIPTION	REPLACEMENT VALUE (EACH)	NUMBER YEAR 1	REQUIRED YEAR 2-5	CAPITAL PER YEAR									
				YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
CONTINUOUS MINERS	650,000	4	2	430,000	430,000	430,000							
PROFILE HEADER MACHINES	750,000	0	2		750,000				750,000				
SHUTTLE CARS	125,000	6	4	167,000									
ROOF BOLTERS	120,000	6	4	167,000									
STAMLER FEEDERS	220,000	3	2	145,000									
AUXILIARY FANS	9,000	6	3			9,000							
PUMPS	5,000	3	3		5,000		5,000						
MATERIAL VEHICLES	240,000	3	3	240,00	160,000		160,000						
TRANSFORMERS	60,000	3	1	20,000									
SWITCHGEAR	14,000	26	0	37,000									
LIGHTENING TRANSFORMERS	7,000	2	1										
TELEPHONES	1,500	4	2										
HIGH TENSION SWITCHES	19,000	2	1	6,000									
CONVEYOR STRUCTURES & BELTS				827,000					376,000				
CONVEYOR DRIVES				100,000					100,000		100,000		
SUB TOTAL				2,152,000	1,345,000	439,000	165,000		1,226,000		100,000		
CONTINGENCY (15%)				323,000	202,000	66,000	25,000		184,000		15,000		
TOTAL CAPITAL DEVELOPMENT EQUIPMENT				2,475,000	1,547,000	505,000	190,000		1,410,000		115,000		
REPLACEMENT ITEMS							2,000,000		2,000,000		2,000,000		
LONGWALL EQUIPMENT				12,500,000									
EXPLORATION						500,000	500,000	500,000					
TOTAL INVESTMENT REQUIREMENTS FOR EXTENDED OPERATIONS				14,975,000	1,547,000	1,005,000	2,690,000	500,000	3,410,000		2,115,000		

TABLE 9-3

SUMMARY OF CAPITAL EXPENDITURE

	5 YEAR	10 YEAR
Longwall Face Equipment	12.5	12.5
Longwall Development Equipment	4.7	6.2
Replacement	2.0	6.0
Exploration	0	1.5
TOTAL	19.2	26.2

TAB[illegible]-4

ANALYSIS OF DIRECT MINING COSTS
DEMONSTRATION PERIOD 5-YEARS

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
DEVELOPMENT COST (A)					
Labour	11.12	11.20	10.63	.00	.00
Electric Power	.58	.66	.66	.00	.00
Materials	8.24	8.24	8.24	.00	.00
	19.94	20.10	19.53		
LONGWALL FACE PRODUCTION COST (B)					
Labour	8.11	3.16	3.05	3.43	2.84
Electric Power	.15	.15	.15	.15	.15
Materials	2.00	2.00	2.00	2.00	2.00
	10.26	5.31	5.20	5.58	4.99
SHARED COSTS (C)					
Fixed Mine Cost	3.71	1.59	1.55	1.90	1.62
Propane	.34	.15	.14	.17	.15
Electric Power Fixed	.54	.23	.22	.27	.14
Other Labour	3.95	1.69	1.65	2.02	1.67
Staff and Supervision	3.92	1.68	1.60	1.86	1.59
SMC UG	3.39	1.45	1.41	1.73	1.48
	15.85	6.79	6.57	7.95	6.65
DIRECT MINING COST*	33.53	13.46	12.96	13.53	11.64

NOTE: All costs are provided on a dollars per long ton raw production basis.

$$* \text{ Direct Mining Cost} = \frac{\text{A x Development Tons + B x Longwall Tons + C x Total Tons}}{\text{Total Tons}}$$

TABLE 9-5

DEVELOPMENT AND LONGWALL PRODUCTION
BY YEAR - DEMONSTRATION PROJECT

YEAR	DEVELOPMENT		LONGWALL		TOTAL	
	LTR	LTC	LTR	LTC	LTR	LTC
1	330 021	239 265	100 510	72 870	430 531	312 135
2	92 157	66 814	913 330	662 164	1 005 487	728 978
3	85 902	62 279	948 290	687 510	1 034 192	749 789
4			843 410	611 472	843 410	611 472
5*			493 810	358 012	493 810	358 012
	508 080	368 358	3 299 350	2 392 028	3 807 430	2 759 756
PROPORTION BY SOURCE	13.3%		86.7%			

* Part year only.

TABLE

ANALYSIS OF DIRECT MINING COSTS
DEMONSTRATION PERIOD 10-YEARS

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5 - 10
DEVELOPMENT COST (A)					
Labour	11.12	11.20	10.63	10.63	10.58
Electric Power	.58	.66	.66	.66	.65
Materials	8.24	8.24	8.24	8.24	8.24
	19.94	20.10	19.53	19.53	19.47
LONGWALL FACE PRODUCTION COST (B)					
Labour	8.11	3.16	3.05	3.43	3.43
Electric Power	.15	.15	.15	.15	.15
Materials	2.00	2.00	2.00	2.00	2.00
	10.26	5.31	5.20	5.58	5.58
SHARED COSTS (C)					
Fixed Mine Cost	3.71	1.59	1.55	1.62	1.70
Propane	.34	.15	.14	.15	.16
Electric Power Fixed	.54	.23	.22	.23	.25
Other Labour	3.95	1.69	1.65	1.72	1.81
Staff and Supervision	3.92	1.68	1.60	1.59	1.67
SMC UG	3.39	1.45	1.41	1.48	1.55
	15.85	6.79	6.57	6.78	7.13
DIRECT MINING COST*	33.53	13.46	12.96	14.41	14.15

NOTE: All costs are provided on a dollars per long ton raw production basis.

$$* \text{ Direct Mining Cost} = \frac{\text{A x Development Tons + B x Longwall Tons + C x Total Tons}}{\text{Total Tons}}$$

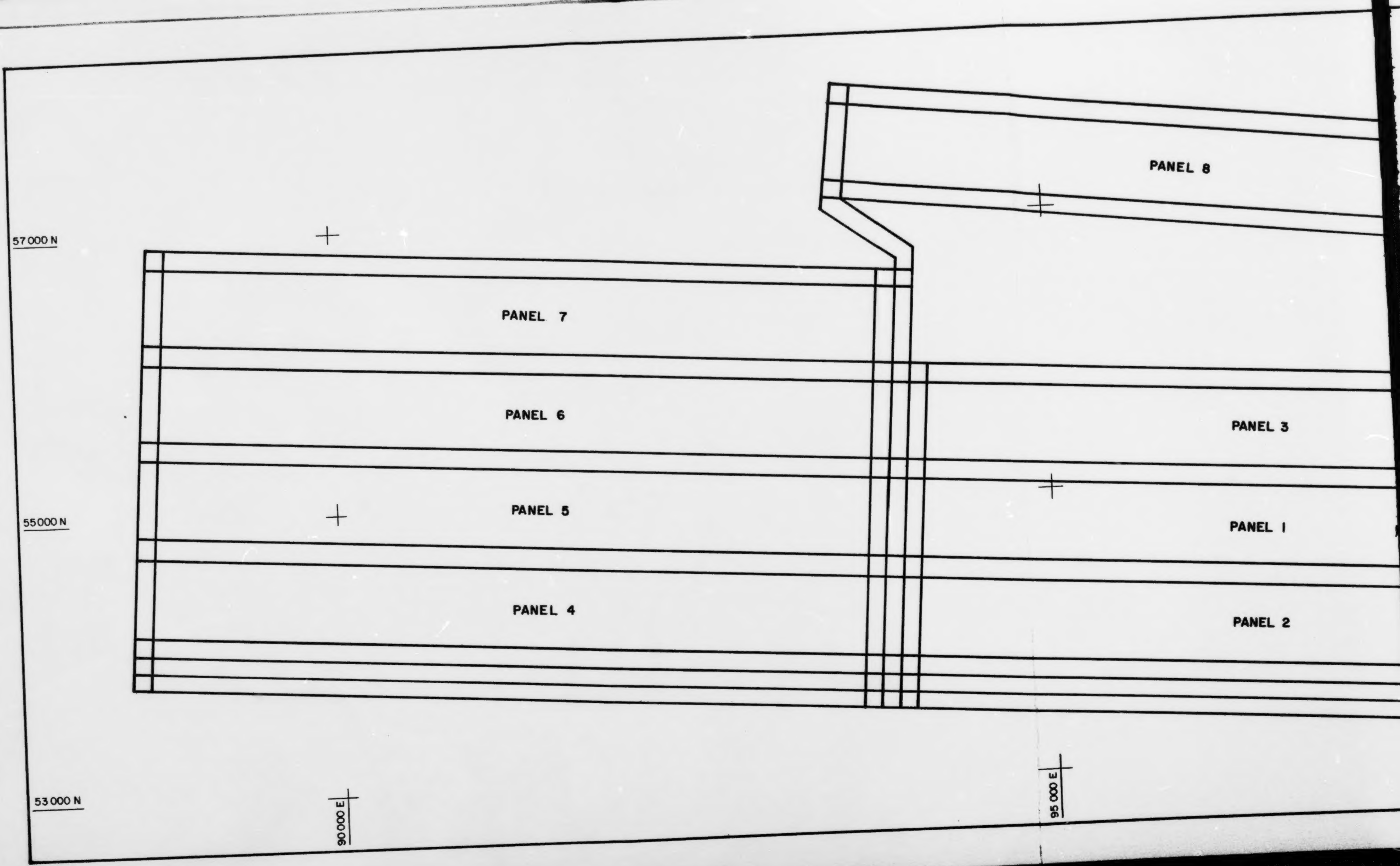
TABLE 9-7

SUMMARY OF ALTERNATIVE PROCUREMENT FINANCING ARRANGEMENTS

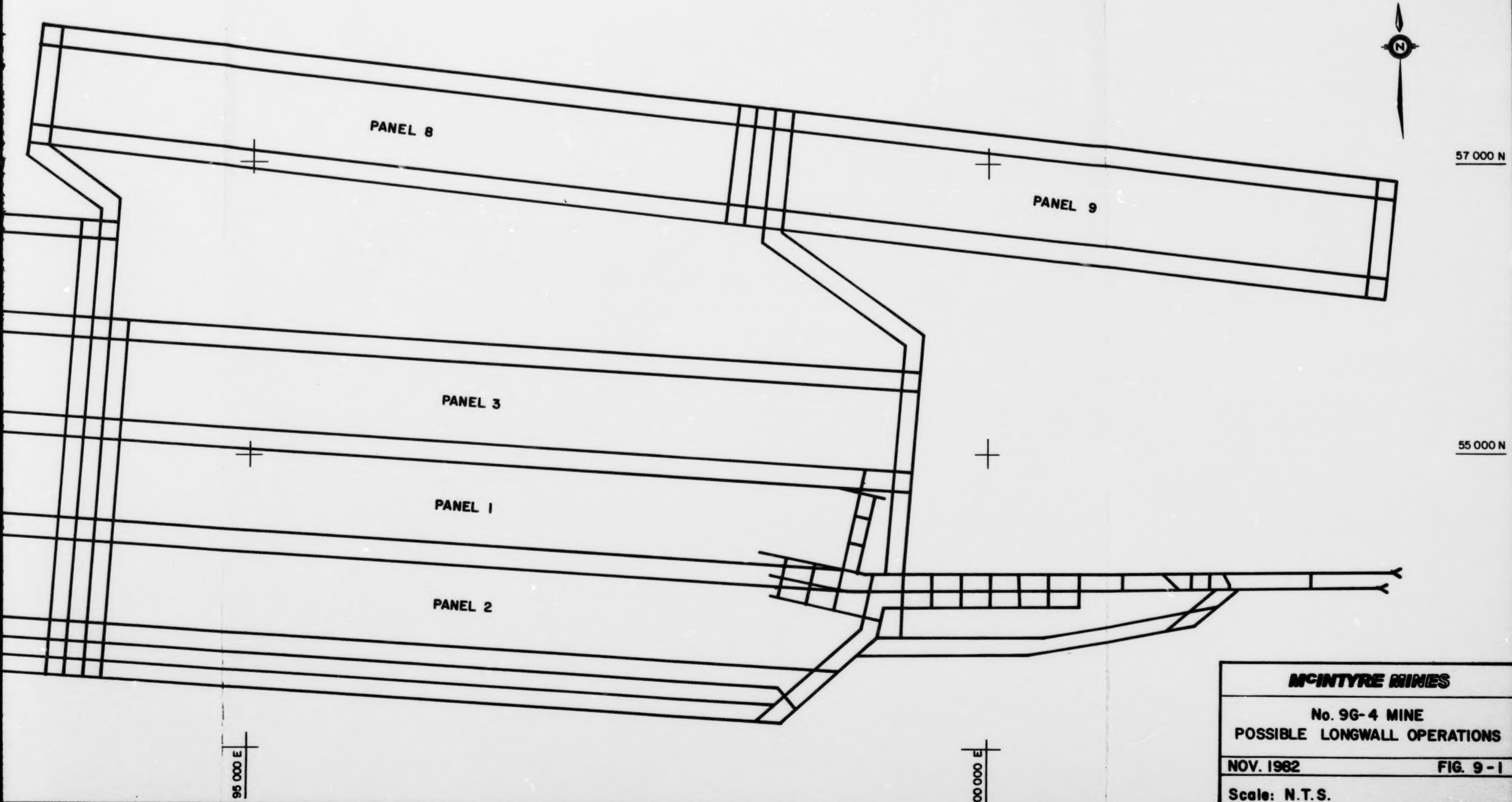
NOTE: Option 1: 5% with order, 10% upon shipment, 85% in 10 equal semi-annual payments. Interest rate = 12.15%

Option 2: 10% with order, 10% upon shipment, 80% in 10 equal semi-annual payments. Interest rate 9%. Note: Financial arrangements cover materials manufactured in country of origin. Requires payment in designated currency.

Option 3: Based on 5-year lease options provided. Total equipment cost recovered in this period and equipment can then be purchased outright for $1.



PANEL 8
57000 N
PANEL 7
PANEL 6
PANEL 3
PANEL 5
PANEL 1
55000 N
PANEL 4
PANEL 2
53000 N
90000 E
95 000 E



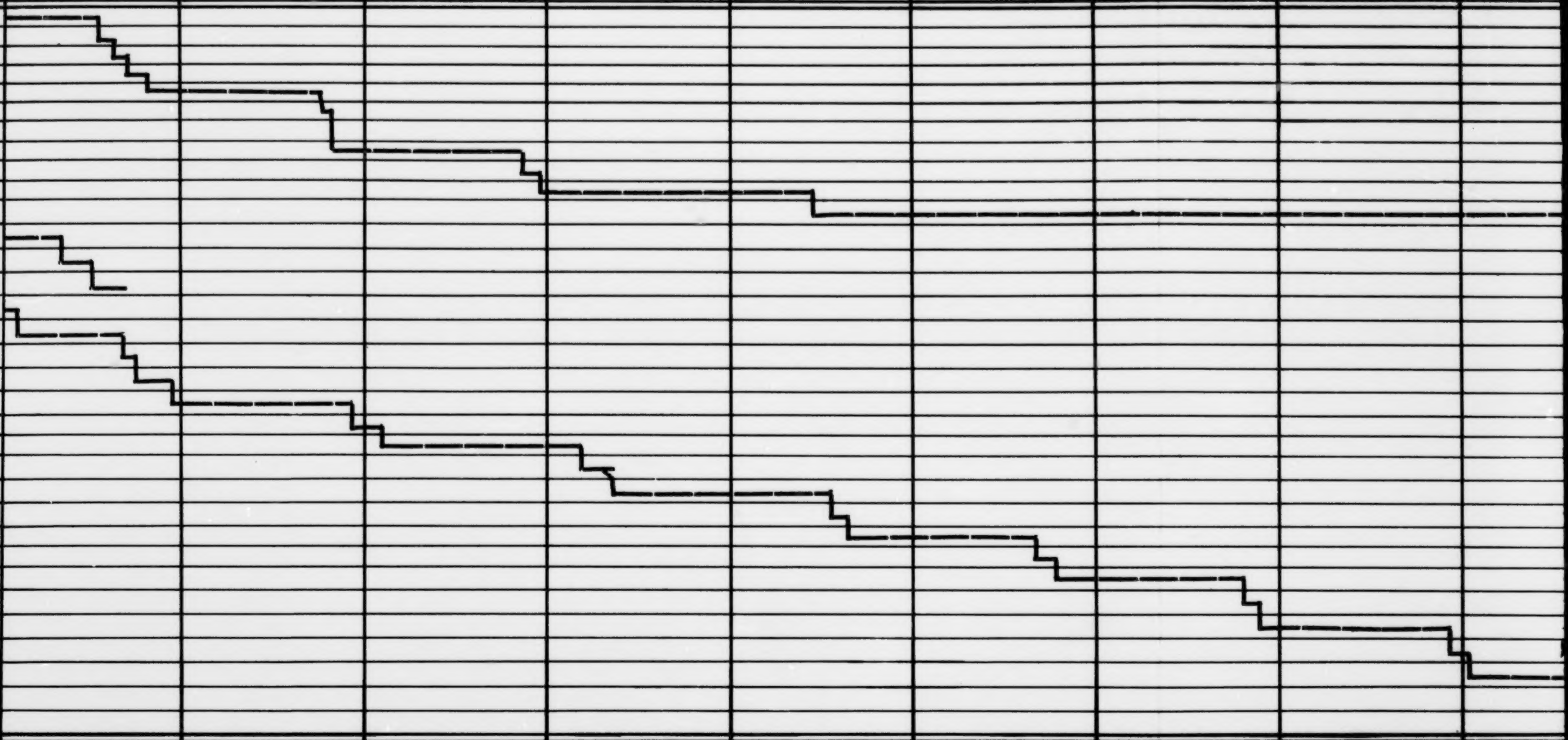
McINTYRE MINES

No. 9G-4 MINE
POSSIBLE LONGWALL OPERATIONS

NOV. 1982

FIG. 9-1

Scale: N.T.S.



YEARS	MANNING	SHIFTS DAILY	1	2	3	4	5	6	7	8	9
DAYS			233	466	699	932	1165	1398	1631	1864	209
No. 1 Panel L.H. Roads	33	3									
No. 2 Face to Anticline	33	3									
Transfer Equipment	33	3									
South Development	22	2									
No. 2 Panel L.H. Roads	22	2									
Transfer Equipment	22	2									
Men Re-Deployed											
No. 3 Panel R.H. Roads	22	2									
No. 3 Face Development	22	2									
Development of Additional	33	3									
Panels	22	2									
No. 3 and 4 Entries	33	3									
North Development No. 2	33	3									
Power Centre	33	3									
North Development No. 1	33	3									
No. 1 Panel R.H. Roads	33	3									
No. 1 Panel Face	33	3									
Installation	66	3									
No. 1 Face Production	63	3									
Transfer Equipment	63	3									
No. 2 Face Production	63	3									
Transfer Equipment	63	3									
No. 3 Face Production	63	3									
Transfer Equipment	63	3									
No. 4 Face Production	63	3									
Transfer Equipment	63	3									
No. 5 Face Production	63	3									
Transfer Equipment	63	3									
No. 6 Face Production	63	3									
Transfer Equipment	63	3									
No. 7 Face Production	63	3									
Transfer Equipment	63	3									
No. 8 Face Production	63	3									
LONGWALL		(L.T.R.)	—	—	—	843,410	843,410	843,410	843,410	843,410	843,
DEVELOPMENT		(L.T.R.)	430,531	1,005,487	1,034,192	145,625	97,568	97,568	97,568	97,568	97.
TOTAL		(L.T.R.)	430,531	1,005,487	1,034,192	989,035	940,978	940,978	940,978	940,978	940,
		(L.T.C.)	312,135	728,978	747,789	717,050	682,209	682,209	682,209	682,209	682,

McI

DEVELOPME

10

NOV. 1982

Scale: N.T.S.

	MANNING	SHIFTS DAILY	1 233	2 466	3 699	4 932	5 1165	6 1398	7 1631	8 1864	9 2097	10 2330
	33	3										
	33	3										
	33	3										
	22	2										
	22	2										
	22	2										
s	22	2										
nt	22	2										
nal	33	3										
	22	2										
	33	3										
2	33	3										
	33	3										
1	33	3										
	33	3										
	33	3										
	66	3										
	63	3										
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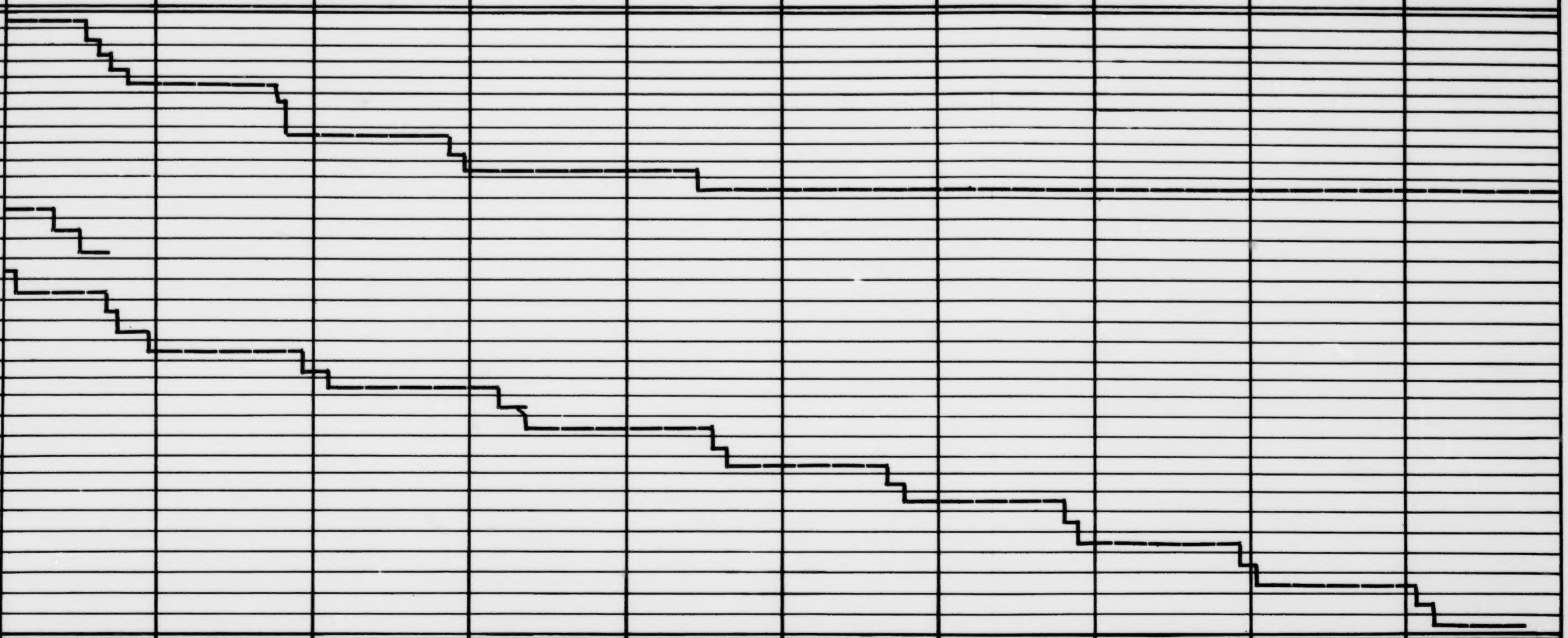
	63	3										
	63	3										
	63	3										
	63	3										
		(L.T.R.)	—	—	—	843,410	843,410	843,410	843,410	843,410	843,410	843,410
		(L.T.R.)	430,531	1,005,487	1,034,192	145,625	97,568	97,568	97,568	97,568	97,568	97,568
		(L.T.R.)	430,531	1,005,487	1,034,192	989,035	940,978	940,978	940,978	940,978	940,978	940,978
		(L.T.C.)	312,135	728,978	747,789	717,050	682,209	682,209	682,209	682,209	682,209	682,209



McINTYRE MINES

DEVELOPMENT AND PRODUCTION
SCHEDULE
10-YEAR PLAN

NOV. 1982 FIG. 9-2

Scale: N.T.S.

POOR

QUALITY

ORIGINAL